OCS Study
MMS 99-0054

Northeastern Gulf of Mexico Chemical Oceanography and Hydrography Study

Annual Report: Year 2

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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Editors

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Worth D. Nowlin, Jr.	TAMU	Program Manager, PI for Task 3
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Douglas C. Biggs	TAMU	Co-PI for Task 1
Norman L. Guinasso, Jr.	GERG/TAMU	Co-PI for Task 1
Matthew K. Howard	TAMU	Co-PI for Task 2
M. C. Kennicutt II	GERG/TAMU	Co-PI for Tasks 1 and 3
Robert O. Reid	TAMU	Co-PI for Task 3

Additionally, Dr. Steven F. DiMarco, Dr. Yaorong Qian, and Ms. Christina Bernal contributed to the authorship of this report.

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Christina Bernal (TAMU; N3, N4, N5)
Dr. Doug Biggs (TAMU; N3, N4, N5)
Ken Bottom (TAMU; N3, N4, N5)
Cheryl Burden (TAMU; N3, N4)
Paul Clark (TAMU; N3, N4, N5)
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Dr. Caesar Fuentes-Yaco (USF; N4)
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Michael Goldstein (TAMU; N3)

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Nancy Hess (UW; N3)
Chuanmin Hu (USF; N3)
Alexey Ivanov (TAMU; N5)
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Patrick Roddy (UD; N5)
Rebecca Scott (TAMU; N3)
Michael Seymour (LSU; N3)
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Ann E. Jochens
Worth D. Nowlin, Jr.

ABSTRACT

The Northeastern Gulf of Mexico Physical Oceanography Program (NEGOM) is supported by the Minerals Management Service (MMS) of the U. S. Department of the Interior. Through a contract between MMS and the Texas A&M Research Foundation, several components of the Texas A&M University System are conducting the Chemical Oceanography and Hydrography study of NEGOM (NEGOM-COH). This report covers activities from July 1998 through June 1999. Data were collected from hydrographic and acoustic Doppler current profiler (ADCP) surveys conducted in the Gulf of Mexico over the continental shelf and upper slope between the Mississippi River Delta and Tampa Bay in water depths of 10 to 1000 m. Additionally, historical and concurrent data from other programs in this region were collected.

Three hydrographic/ADCP surveys, N3, N4, and N5, were conducted with 98, 98, and 102 hydrographic sampling stations and 101, 112, and 96 expendable bathythermograph stations on respective cruises. Each survey also included continuous ADCP measurements along the cruise track. At each hydrographic sampling station continuous profiles were made of conductivity, temperature, pressure, downwelling irradiance, fluorescence, and light transmission. Up to twelve water samples were taken at each station and analyzed for dissolved oxygen and six nutrients: nitrate, nitrite, phosphate, silicate, ammonium, and urea. At approximately 60 stations on each cruise, water samples were filtered and analyzed for phytoplankton pigments at the surface, from the chlorophyll maximum determined from fluorescence, and from the low light regime immediately below the maximum. Pigments were determined using high performance liquid chromatography. At about 60 stations on each cruise, water samples were filtered and analyzed for particulate matter concentrations at surface, middle, and bottom water depths and for particulate organic carbon and particulate organic nitrogen concentrations at surface and bottom water depths. Bottle salinity was measured routinely at the shallowest and deepest stations on each cross-shelf line. The instrumentation as well as calibration and sampling procedures are described in this report. The collected data were subjected to stringent quality assurance/quality control procedures.

Selected preliminary results are presented from the first four cruises in November 1997, May 1998, July/August 1998, and November 1998. Included is a description of forcing functions at the times of the cruises: winds, river discharge, and offshelf eddies. The general distributions of temperature, salinity, dissolved oxygen, nutrients, particulates, and pigments are discussed. These distributions evidenced the influence of river discharges in the form of enhanced nutrient concentrations and particulate loadings, and higher chlorophyll *a* concentrations near riverine sources. Nutrients were found to be positively correlated with each other and negatively correlated with chlorophyll *a* and oxygen. Chlorophyll *a* was positively correlated with oxygen and particulate matter concentrations.

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ACRONYMS AND ABBREVIATIONS

ADCP	acoustic Doppler current profiler
AVHRR	Advanced Very High Resolution Radiometer satellite
CCAR	Colorado Center for Astrodynamics Research
CTD	conductivity-temperature-depth
DGPS	differential Global Positioning System
GPS	Global Positioning System
HPLC	high performance liquid chromatography
LATEX	Louisiana-Texas Shelf Physical Oceanography Program
NEGOM	Northeastern Gulf of Mexico Physical Oceanography Program
NEGOM-COH	Northeastern Gulf of Mexico Chemical Oceanography and Hydrography
MMRP	Marine Mammal Research Program at TAMU-Galveston
MMS	Minerals Management Service, U.S. Department of the Interior
NOAA	National Oceanic and Atmospheric Administration
PAR	photosynthetically available radiation
PI	principal investigator
PM	particulate matter
POC	particulate organic carbon
PON	particulate organic nitrogen
QA/QC	quality assurance/quality control
RDI	RD Instruments, Inc.
R/V	research vessel
SAIL	Serial ASCII Interface Loop system
SSC	sea surface chlorophyll fluorescence
SSHA	sea surface height anomaly
SSS	sea surface salinity
SST	sea surface temperature
TAMU	Texas A&M University
USF	University of South Florida
UTC	Universal Coordinated Time
XBT	expendable bathythermograph probe

1 EXECUTIVE SUMMARY

1.1 Introduction

The Minerals Management Service (MMS) of the U.S. Department of the Interior supports the Northeastern Gulf of Mexico Physical Oceanography Program (NEGOM). NEGOM is divided into six study units, one of which is the Chemical Oceanography and Hydrography Study (NEGOM-COH). NEGOM-COH covers the east Louisiana-Mississippi-Alabama-west Florida continental shelf and upper slope from the Mississippi River delta to Tampa Bay in water depths of 10 to 1000 m. This report focuses on the second year of work of NEGOM-COH covering the period July 1998 through June 1999. It does not contain detailed syntheses or interpretation of data collected; those will be detailed in the Final Synthesis Report.

The contract for NEGOM-COH was awarded to the Texas A&M Research Foundation on 30 September 1997. Through the contract, components of the Texas A&M University System, a combination of Texas institutions of higher learning and Texas state agencies dedicated to training, research, and extension, conduct the NEGOM-COH study. In addition to support from the MMS, financial backing for NEGOM-COH is provided by Texas A&M University (TAMU), a component of the System. TAMU is assisted in this program by a subcontract with Dr. Robert R. Leben of the University of Colorado.

The major objective of NEGOM-COH is to describe spatial and temporal distributions and variations of hydrographic variables, and the processes that contribute to them. It will be met through completion of a three year field program of hydrographic/acoustic Doppler current profiler (ADCP) cruises in the spring, summer, and fall seasons, after which observations will be synthesized, interpreted, and reported to provide a more complete understanding of circulation and distribution of properties over the study area.

Program management is provided by Dr. Worth D. Nowlin, Jr., Program Manager, and Dr. Ann E. Jochens, Deputy Program Manager. Study tasks are:

- Task 1, Field Work and Data Collection
  - Dr. Douglas C. Biggs, Co-principal investigator (Co-PI)
  - Dr. Norman L, Guinasso, Jr., Co-PI
  - Dr. M. C. Kennicutt II, Co-PI
- Task 2, Data Reduction/Analysis and Synthesis
  - Dr. Ann E. Jochens, Principal Investigator (PI)
  - Dr. Matthew K. Howard, Co-PI
- Task 3, Information/Data Synthesis and Technical Reports
  - Dr. Worth D. Nowlin, Jr., PI
  - Professor Robert O. Reid, Co-PI
  - Dr. M. C. Kennicutt II, Co-PI

1.2 Field Data

Three hydrographic/ADCP survey cruises were conducted in the report period: Cruise N3 during 25 July - 6 August 1998; cruise N4 during 13-24 November 1998; and cruise N5 during 14-28 May 1999. Conductivity-temperature-depth (CTD) and bottle sampling were completed at 98, 99, and 102 stations and expendable bathythermographs (XBT) were launched successfully at 101, 112, and 96 stations. ADCP data were recorded continuously along track on N3 and N5; but due to equipment malfunction, data were collected only along lines 1 through 4 on cruise N4. The standard pattern of station locations and line numbers, as well as bathymetry and geographic locations, are shown in Figure 1.2.1. At each CTD/bottle station, continuous profiles were made of conductivity, temperature, dissolved oxygen, downwelling irradiance, backscatterance, fluorescence, and percent transmission. Up to 12 water samples were taken at each station and analyzed for dissolved oxygen and six nutrients: nitrate, nitrite, phosphate, silicate, urea, and ammonium. Typically at 60 stations, water samples were analyzed for phytoplankton pigments, particulate matter, and particulate organic carbon/particulate organic nitrogen. Bottle salinities were measured at the innermost and seawardmost stations of each cross-shelf line, as well as at supplemental stations for problem solving associated with bottle sampling. XBT stations were taken between cross-shelf CTD stations to increase the resolution of the temperature data to ~10 km. Near-surface temperature, salinity, and fluorescence were logged every two minutes while the ship was underway or stopped at stations. To calibrate the underway fluorescence, 101, 108, and 102 underway water samples were analyzed for chlorophyll content. After collection, the data sets were processed for compliance with quality assurance and quality control criteria.

1.3 Technical Discussion

This second annual report focuses on the data collection and processing activities of NEGOM-COH from July 1998 through June 1999. Section 5 provides a brief description and examples of representative forcing functions—wind, river discharge, and offshelf eddies—and of the water column properties for the first four NEGOM cruises: N1 (November 1997), N2 (May 1998), N3 (July/August 1998), and N4 (November 1998). No detailed syntheses of data are given, but the results of several preliminary analyses associated with interesting phenomena are presented to show examples of representative products to be provided in the final report.

1.3.1 Forcing Functions

Ancillary data sets are being acquired to allow examination of various forcing functions that influence water properties and circulation in the NEGOM study area. These include meteorological data from marine buoys and coastal land stations, river discharge rates, and sea surface height anomaly fields from satellite altimeters.

Production of gridded wind fields allowed examination of the time series of daily winds over the study area. Throughout most of the N1 cruise, winds were directed to the south and

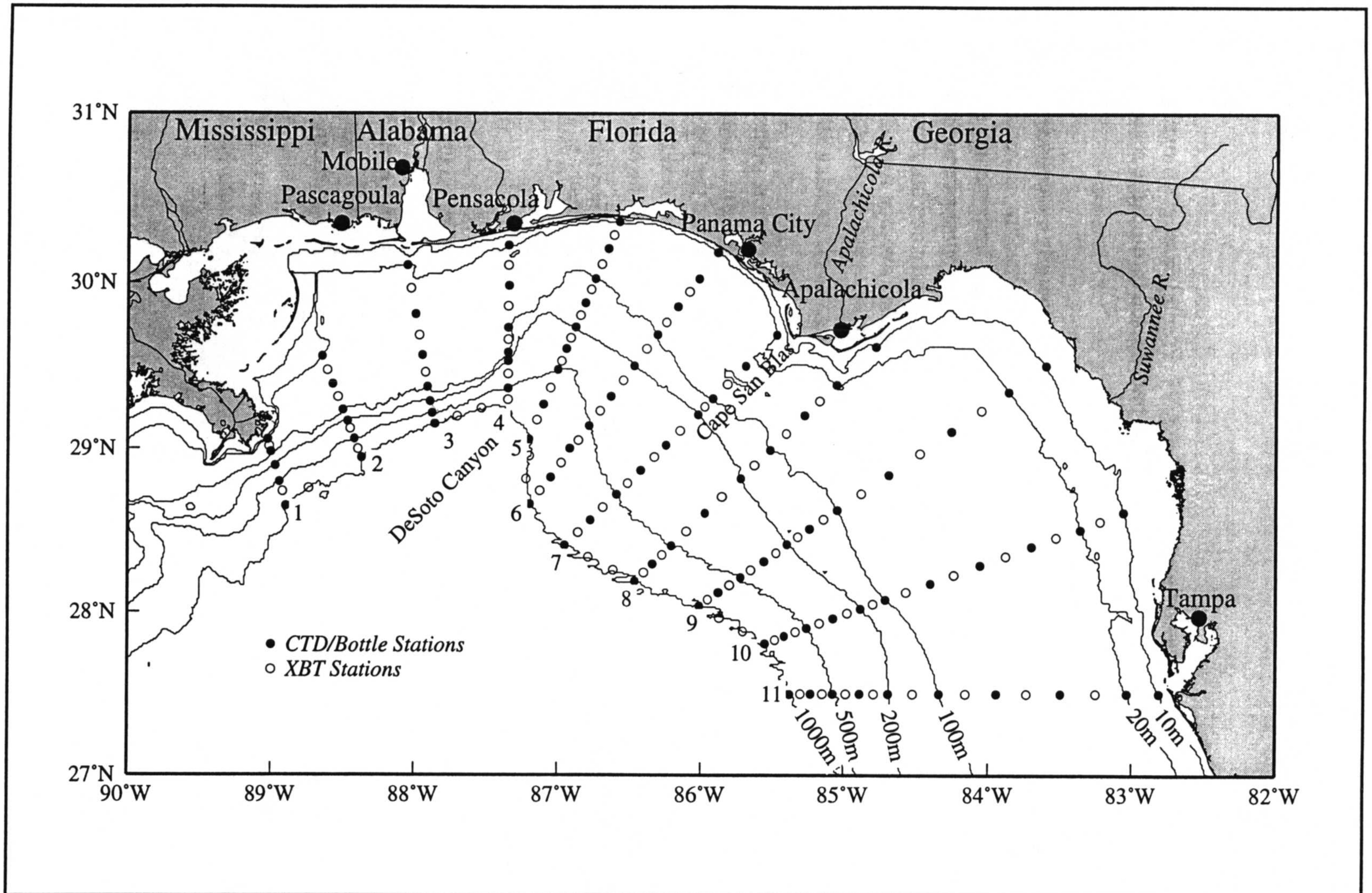


Figure 1.2.1. Station locations and cross-shelf line numbers for NEGOM hydrographic/ADCP cruises and geographic locations in the study area. Line numbers are given at the offshore end of the lines.

southwest, in response to the presence of high pressure over the continent to the north. On N2, there were several periods with upwelling-favorable, but weak, westerly winds, particularly near-shore.

Winds during the N3 cruise were generally weak and varied from westerly to easterly. Winds were variable in direction and speed throughout cruise N4. Frontal passages moved through the study area during N1, N2, and N4, but no major cold fronts passed through the region during the N3 cruise (summer 1998).

During winter 1998, discharge from rivers in the study region generally exceeded the long-term mean, many by significant amounts. In spring 1998, the Mississippi River continued to discharge at a rate well above its mean. Other rivers had flows below their means, except in late April 1998, when rivers west of the Apalachicola exhibited a brief pulse of much greater than average discharge. Rivers examined east of Cape San Blas generally had only one episode (in March) of high discharge during the first half of 1998. Greater than average river discharge into the Gulf from Mississippi Sound to Cape San Blas during early 1998 is consistent with an extensive surface expression of fresh water observed during cruise N2 in May 1998.

Cyclonic and anticyclonic eddies in deep water near the shelf have been observed to have profound influence on the outer shelf circulation in the northeastern Gulf. During the four cruises, an anticyclonic eddy was located to the west of and extending into the DeSoto Canyon. The shape of these eddies varied from cruise to cruise, but they influenced an anticyclonic offshore circulation at the shelf edge in the western part of the study area. The eastern shelf was under the influence of cyclonic flow. These eddies variously moved shelf water offshore and deep water onshore.

1.3.2 Integration of Water Column Chemistry

The water column chemistry component is designed to provide an integrated understanding of the chemistry of dissolved oxygen, nutrients, and particulate constituents in the study area. Dissolved and particulate fractions within the water column are closely coupled through the processes of photosynthesis, excretion, decomposition, and diagenesis. Particulate water column constituents (particulate matter (PM), particulate organic carbon (POC), and phytoplankton pigments) are characterized as living and non-living, organic and inorganic, and phytoplankton-derived. Temperature, salinity, dissolved oxygen, nutrient, PM, POC, and phytoplankton pigment distributions were examined for cruises N1 through N4. Preliminary results are presented in Section 5.2 and several are summarized below.

Nutrient distributions during the cruises exhibited classical marine patterns with near surface waters (down to 100 m) depleted in nutrients due to biological uptake, deep waters enhanced in nutrients due to remineralization, and enhanced concentrations near river outflows due to the inflow of nutrient rich waters. In shallow depths the entire water column was often depleted in nutrients since the euphotic zone reached to the bottom of the water column. The major phytoplankton nutrients (nitrate, phosphate, and silicate) showed variations with location, water depth, and time of year.

During most cruises at most locations, dissolved oxygen concentrations in near-surface waters were near or above the atmospheric equilibrium. On occasion, elevated near-surface water dissolved oxygen concentrations were observed due to the local production of oxygen by photosynthesis. Near-bottom water dissolved oxygen concentrations decreased with increasing distance from shore and increasing bottom water depth. In the spring and summer, near-shore bottom oxygen levels became depleted over those observed during the fall sampling periods. Seasonal variations at shallow water sites coincided with increased exposure of the sea bottom to sunlight.

In general, waters in the study area had high light transmission during all seasons, indicating few particles were present. Light transmission was lowest and PM concentrations greatest close to the Mississippi River, reflecting riverine inputs of particulate matter. Some reduced transmission was indicated at the shallowest stations over the eastern study area, indicating outflow of particulate-laden water from the Apalachicola and Suwannee Rivers. In general, POC in near-surface waters accounted for 25 to 40% of the PM, while in near-bottom water POC was about 7 to 20% of the PM.

Near-surface water chlorophyll *a* concentrations generally were similar to the maximum concentrations in vertical profiles. In contrast to PM and POC distributions, chlorophyll *a* was relatively uniformly distributed across the shelf regions of the study area. Elevated chlorophyll *a* values were associated with discharges from the smaller rivers that carried moderate PM loads and nutrient-rich waters. Regionally, near-surface chlorophyll *a* concentrations differed during each sampling period with highs in the southeast region in November 1997, along the Mississippi Bight in May 1998, off the Mississippi River in July/August 1998, and a uniform distribution in November 1998. The predominant accessory pigments detected were 19-butanoyloxyfucoxanthin, fucoxanthin, 19-hexanoyloxyfucoxanthin, chlorophyll *b*, c_2, c_3, zeaxanthin, and β-carotene. Other accessory pigments that were present in trace amounts included: violaxanthin, peridinin, prasinoxanthin, diadioxanthin, diatoxanthin and alloxanthin.

Water column properties were cross-correlated. Potential temperature was positively correlated with time of year, distance from shore, depth in the water column, and total depth of the water column. Salinity was negatively correlated with nutrient and particulate matter concentrations and positively correlated with light transmission. Dissolved nutrients were positively correlated with each other and with PM and POC. However, nutrient concentrations were only moderately correlated with phytoplankton pigment concentrations suggesting that a significant non-living particulate matter source affected particulate distributions in the study area (i.e., an overriding influence of river discharges). Phytoplankton pigment concentrations were negatively correlated with salinity, with some being more highly correlated than others (β-carotene, diadioxanthin, and alloxanthin). Chlorophyll *a* was positively correlated with other phytoplankton pigments.

2 INTRODUCTION

The first annual report for NEGOM-COH detailed the program objectives, tasks, and participants, the data collection and processing for cruises N1 and N2, and the results of preliminary examination of the N1 data set (Jochens and Nowlin, 1998). The second annual report focuses on the period from July 1998 through June 1999 and includes data acquisition on cruises N3, N4, and N5, and QA/QC and analysis for selected data from cruises N2, N3, and N4. Information on the NEGOM-COH program is provided on a publicly accessible web page on the internet at http://negom.tamu.edu/negom.

2.1 Overview of Cruise Schedule and Nomenclature

Three hydrographic/ADCP cruises were conducted aboard *R/V Gyre* during this report period. The cruises, their various designators, and their start and end dates are given in Table 2.1.1. The NEGOM ID is the shorthand identifier used in this report. The cruise ID number is the standard cruise identifier widely used in the oceanographic community. The first two characters are the year of the cruise, the third character is the ship identifier, G for *Gyre*, and the last two characters are the number of the ship's cruise for that year. Typical station locations and cross-shelf line numbers are shown in Figure 1.2.1.

Table 2.1.1. Cruise identifiers and dates.

Survey No.	Start Date	End Date	NEGOM ID	Cruise ID
3	25 July 1998	6 August 1998	N3	98-G-10
4	13 November 1998	24 November 1998	N4	98-G-15
5	15 May 1999	28 May 1999	N5	99-G-07

2.2 Programmatic Changes

Near-surface temperature and velocity spatial scales for NEGOM cruises N1 through N4 were estimated. Temperature scales were based on temperatures recorded at about 10-m depth from both XBT drops and CTD casts. Scales were estimated by interpolating the 10-m temperature data along each cruise track to regularly spaced intervals and removing a quadratic fit to take out the large spatial scale background field. A fast Fourier transform was used to estimate the auto-correlation function of the residual series. The spatial scale was defined as the first zero-crossing of the auto-correlation function. Spatial scales for the four cruises are summarized in Table 2.2.1; scale values marked with an asterisk are considered less reliable because the ratio of the variance of the residual temperature series (raw minus quadratic fit) to the variance of the raw temperature series is less than 0.10.

Table 2.2.1. Spatial scales (km) of temperature from a depth of 10 m.

Line No.	N1	N2	N3	N4
1	5.26*	5.59	6.14*	6.34
2	7.47	13.68	10.90	9.13*
3	8.84*	10.76	10.83	10.17*
4	15.67*	12.76	10.29	12.55
5	10.46*	15.89	8.84	22.06
6	23.91	17.42	20.33	27.38
7	18.54*	26.16	15.73	23.89
8	20.13	22.44	9.55	25.65*
9	18.85	23.55*	30.34	25.77
10	28.51	16.75	20.90	15.74*
11	26.14	20.01*	14.06	21.92
1000m	17.50*	16.44	18.60	27.43

* less reliable; small ratio of variances of residual to raw temperatures

In general, cross-shelf scales are smaller in the western region of the NEGOM study area than in the east on the West Florida Shelf. Values range from 5-6 km close to the Mississippi River Delta (line 1), where there is steep bathymetry, and increase to 10-15 km on the western edge of DeSoto Canyon (lines 2-5), where the continental shelf broadens slightly before dropping off rapidly into the canyon. On the eastern edge of DeSoto Canyon and on the West Florida Shelf (lines 6-11), the bathymetry is less steep and the fall-off of the continental shelf and slope is gradual. There, spatial scales range from 20-30 km.

Along the 1000-m isobath, alongshelf scales range from 16-27 km. On N4, scales estimated from XBT/CTD data (~10-m depth and ~10 km apart) were similar to those from the ship's flow-through thermosalinograph (~3-m depth and logging data every 2 minutes).

Spatial scales at 14 m depth based on current speeds from ADCP measurements were estimated using the same procedures as used for temperature scales. The number of independent samples per line for velocity were roughly every 1.5 km, which is considerably denser than the 10 km for temperature. Table 2.2.2 summarizes the along- and cross-track velocity component scales for each of the four cruises. Again, a quadratic fit was removed prior to estimating the auto-correlation function. On cruise N4, ADCP data were taken only on lines 1-4 due to instrument malfunction.

Table 2.2.2. Spatial scales (km) of ADCP current velocity components at a depth of 14 m. Along-track scales are given first, then cross-track scales.

Line	N1		N2		N3		N4	
Number	Along	Cross	Along	Cross	Along	Cross	Along	Cross
1	5	5	6	3	4	5	2	5
2	7	4	12	11	14	14	9	11
3	10	7	10	10	7	13	5	3
4	6	6	14	13	3	4	9	9
5	25	6	7	18	12	13	*	*
6	20	11	19	29	22	20	*	*
7	27	12	25	15	14	25	*	*
8	32	25	20	21	16	24	*	*
9	29	14	34	21	36	26	*	*
10	21	19	27	32	32	25	*	*
11	23	20	17	19	12	23	*	*
1000m	50	51	31	30	35	18	*	*

* no data available for analysis

As with temperature scales, scales of velocity components generally are smaller in the western region than on the broad shelves of the eastern region. Scales increase from 2-6 km near the Mississippi River Delta (line 1) to nominally 4-18 km on lines 2-5. The scales increase on the West Florida Shelf to a range of 20-35 km. The longest spatial scales are found along the 1000-m isobath; these probably are due to the influence of eddies. There is no clear relation of along-track versus cross-track scales, although there seems a tendency for along-track scales to be slightly greater than cross-track. One might expect cross-shelf scales to be smaller than along-shelf scales (Nowlin et al., 1998a).

Based on these results, one, rather than two, XBTs were deployed between CTD station locations along the 1000-m isobath beginning with cruise N5.

2.3 Report Organization

This is the second annual report of the NEGOM-COH study, reporting on: data-gathering efforts; equipment, measurement and analytical methodologies employed; results of quality control exercises and determinations; status of data archiving and data sharing with other contractors; and preliminary data analysis and results of data collected to date. More extensive analyses or syntheses of the information will be provided in the final Synthesis Report at the conclusion of the study. Section 3 of the report details the acquisition of the chemical oceanography, hydrography, and ADCP measurements and collateral data assembly. Section 4 discusses data processing efforts and data quality control methods and results. Section 5 provides technical discussion of the data, with samples of data products for the various data types. All times are reported in Universal Coordinated Time (UTC) unless stated otherwise.

3 DATA ACQUISITION

An overview of the NEGOM-COH data acquisition activities for cruises N3, N4, and N5 is presented in this section. It covers *in situ* sampling efforts and the instrumentation, calibration, and sampling procedures, and summarizes field data collection and collateral data assembly.

3.1 General Description of Surveys

From July 1998 through June 1999, three hydrographic/acoustic Doppler current profiler (ADCP) surveys (N3, N4, and N5) were conducted aboard the *R/V Gyre*. A Sea-Bird SBE-911*plus* was used on each cruise. Conductivity-Temperature-Depth (CTD)-Rosette stations were occupied on each cruise at nearly identical station locations. A test station, at which all bottles were tripped in the salinity minimum water at about 700-800 m, was made on each cruise to test the instrumentation and equipment. Expendable bathythermograph (XBT) probes were launched between CTD stations. ADCP data were collected along the cruise tracks. Navigation data and station locations were determined by differential Global Positioning System (DGPS).

The surveys consisted of 11 lines of CTD and XBT stations perpendicular to the bathymetry (cross-shelf lines). Lines are numbered from 1 to 11, west to east. The naming convention for cross-shelf lines is:

First and second characters:	NEGOM cruise number (N3, N4, or N5)
Third character:	L = Line
Fourth and fifth characters:	Line number (1 through 11)
Sixth character:	S = Sequence
Seventh and eighth characters:	Sequence number of station on the line
Ninth character:	C = CTD station type; X = XBT station type

Stations on each cross-shelf line are numbered sequentially from innermost to outermost station regardless of station type. As an example, station N3L06S03C is the third station from the coast on line 6 and is a CTD station taken on cruise N3. Where it is clear which station type is being described, the ninth character is not included in the tables below.

XBTs were deployed between pairs of cross-shelf lines along the 1000-m isobath. The station naming convention for these stations is:

First and second characters:	NEGOM cruise number (N3, N4, or N5)
Third character:	X = Segment between two cross-shelf lines
Fourth and fifth characters:	Starting cross-shelf line number of segment
Sixth and seventh characters:	Ending cross-shelf line number of segment
Eighth character:	Sequence number of station between lines
Ninth character:	X = XBT station type

For example, station N4X0910MX is the second XBT deployed on cruise N4 between lines 9 and 10 (M = midway).

3.1.1 Cruise N3

The third NEGOM-COH hydrography cruise (N3) was conducted on the *R/V Gyre* from 25 July – 6 August 1998. It was staged out of Gulfport, MS, and returned to Galveston, TX. Dr. Douglas C. Biggs and Dr. Norman L. Guinasso, Jr., were co-chief scientists. One hundred CTD stations, including one test station located in deep water in DeSoto Canyon (Station 000, N3TEST04) and one supplementary station in Mississippi Canyon (Station 099, N3M00001), were completed and 108 XBT drops were made. The locations of the CTDs and XBTs and cruise track are shown in Figure 3.1.1. The test station was taken approximately at the location of the seawardmost CTD station on line 4. The cruise track starts at this location and runs along the 1000-m isobath to the seawardmost station on line 11 where the CTD/XBT station series began. XBTs were dropped and ADCP data were collected along this 1000-m track. Only locations of the 101 successful XBT drops are shown in Figure 3.1.1. Station number, date, time, location, water depth, and number of bottles tripped at each CTD station are given in Table 3.1.1.

Stations at which bottle samples were taken are summarized in Table 3.1.2. Nutrients and oxygen were measured from every Niskin bottle sampled. Salinity was measured at the inner-most station and the 1000-m isobath station on each cross-shelf line, the test station, and the supplemental station for a total of 24 stations. Pigment samples were taken at the top, at the chlorophyll-maximum (as estimated from the downcast fluorescence trace), and in the low light regime immediately below the chlorophyll-maximum at 58 stations. Total particulate matter (PM), particulate organic carbon (POC), and particulate organic nitrogen (PON) were measured from the shallowest and deepest bottles and, for PM, from a middle, "clear water" bottle at 60 stations.

The location, date, time, total water depth, and probe type of the 101 XBT drops that produced usable data are given in Table 3.1.3. The 150kHz broad-band ADCP was operated continuously along the survey track (Section 3.2.3). Flow-through near-surface temperature, conductivity, and fluorescence were logged every 2 minutes (Section 3.2.5). Surface samples were filtered and analyzed for chlorophyll *a* content to calibrate the flow-through fluorometer at 101 locations.

Seven complementary research efforts were accommodated on summertime cruise N3. Thirty ARGOS-tracked drifters were launched for Dr. James M. Price of MMS. A marine mammal survey with bigeye binoculars was carried out by Dr. Sasha Drobyshevski from the TAMU-Galveston Marine Mammals Research Program (MMRP) to continue and extend similar surveys done on N1 and N2. MMRP survey objectives are to obtain data on the distribution and abundance of marine mammals and to compare sightings with locations of surface temperature, salinity, and fluorescence fronts. Ms. Nancy Hess, a graduate student of Dr. Christine Ribic at the University of Wisconsin, was assisted by Mr. Mike Seymour, an undergraduate student at

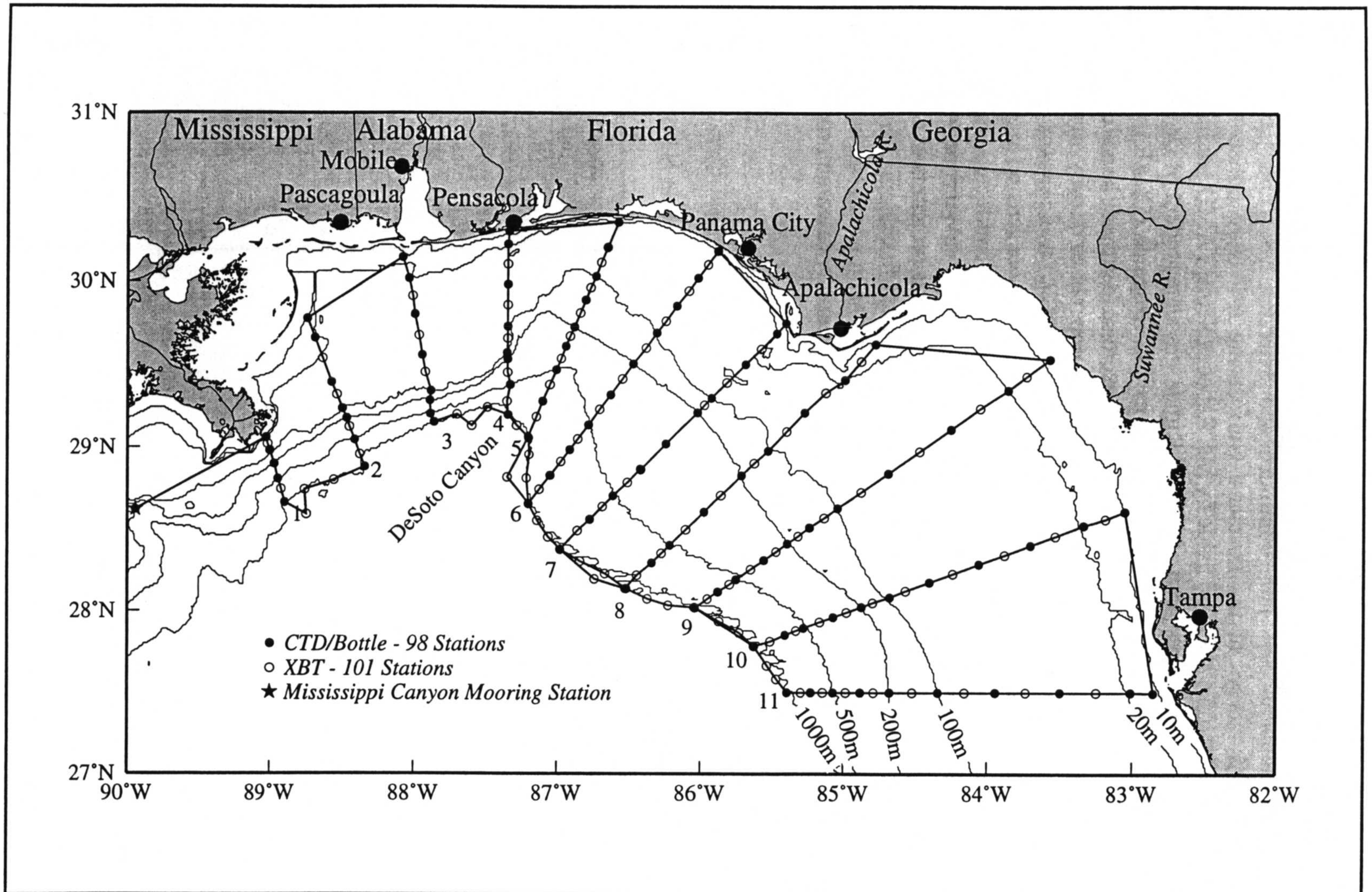


Figure 3.1.1. Station locations for cruise N3 conducted 25 July - 6 August 1998. CTD stations began with the most seaward station on line 11. The thick line shows the cruise track, which began at the location of the most seaward station on line 4.

Louisiana State University, and Mr. Michael Goldstein, a graduate student in Wildlife and Fisheries Science Department at TAMU, to carry out a companion census of seabird distributions and abundances. This continued and extended Ms. Hess' participation in summertime seabird surveys of the northeast Gulf during *R/V Gyre* cruises 96-G-06 and 97-G-07. Fifteen plankton tows were made by Ms. Rebecca Scott, TAMU graduate student of Dr. Biggs, for her M.S. thesis research. Mr. Josh Rigler, graduate student of Dr. George Born and Dr. Robert Leben, Colorado Center for Astrodynamics Research (CCAR), University of Colorado, participated in the cruise as part of a training exercise to provide hands on experience in collection of *in situ* oceanographic data used to compute upper layer density, dynamic height, and geostrophic volume transport for comparison with TOPEX/Poseidon and ERS-2 radar altimetry. Dr. Chuanmin Hu and Mr. Denis Nadeau, from the remote sensing group headed by Dr. Frank Muller-Karger at the University of South Florida (USF), conducted irradiance casts and collected dissolved organic carbon data for comparison with SeaWiFS data. Ms. Cheryl Burden, M.S. student in oceanography at TAMU whose MS thesis project is to determine and quantify the dominant modes of offshelf sediment transport in the Mississippi Canyon, retrieved and then redeployed a current meter mooring in Mississippi Canyon which had been collecting data since May 1998. Further information on these complementary research programs can be obtained from the scientists involved.

Table 3.1.1. Times and locations for CTD stations on cruise N3.

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
000	N3TEST04	26-JUL-1998	16:41:54	29.194575	-87.348250	980.	12
001	N3L11S18	27-JUL-1998	12:44:04	27.500080	-85.395098	992.	12
002	N3L11S16	27-JUL-1998	14:56:55	27.500658	-85.225935	748.	12
003	N3L11S14	27-JUL-1998	16:56:41	27.500395	-85.075703	488.	12
004	N3L11S12	27-JUL-1998	20:14:22	27.498985	-84.886485	288.	12
005	N3L11S10	27-JUL-1998	22:07:48	27.500232	-84.681948	198.	12
006	N3L11S08	28-JUL-1998	00:59:23	27.499115	-84.343575	100.	12
007	N3L11S06	28-JUL-1998	03:58:54	27.499222	-83.943143	51.	5
008	N3L11S04	28-JUL-1998	07:03:27	27.499472	-83.496608	35.	5
009	N3L11S02	28-JUL-1998	10:28:18	27.500342	-83.009483	12.	5
010	N3L11S01	28-JUL-1998	11:43:02	27.496920	-82.853317	10.	4
011	N3L10S01	28-JUL-1998	20:08:21	28.607138	-83.052715	9.	4
012	N3L10S03	28-JUL-1998	22:17:22	28.520875	-83.331748	20.	4
013	N3L10S05	29-JUL-1998	00:49:31	28.400247	-83.701397	30.	4
014	N3L10S07	29-JUL-1998	03:14:17	28.286145	-84.058880	35.	4
015	N3L10S09	29-JUL-1998	05:42:40	28.175358	-84.403378	56.	5
016	N3L10S11	29-JUL-1998	07:45:57	28.083790	-84.681435	85.	11
017	N3L10S13	29-JUL-1998	09:27:10	28.023458	-84.878208	197.	12
018	N3L10S15	29-JUL-1998	11:12:19	27.961125	-85.073535	310.	12
019	N3L10S17	29-JUL-1998	13:05:02	27.895987	-85.277038	490.	12
020	N3L10S19	29-JUL-1998	14:41:11	27.852705	-85.411623	651.	11

Table 3.1.1. Times and locations for CTD stations on cruise N3 (continued).

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
021	N3L10S21	29-JUL-1998	17:24:36	27.782648	-85.630720	994.	12
022	N3L09S21	29-JUL-1998	22:48:39	28.016968	-86.042252	985.	11
023	N3L09S19	30-JUL-1998	01:07:28	28.116248	-85.877852	669.	12
024	N3L09S17	30-JUL-1998	03:30:22	28.190623	-85.754563	494.	12
025	N3L09S15	30-JUL-1998	05:46:43	28.309618	-85.562852	304.	12
026	N3L09S13	30-JUL-1998	07:33:46	28.411222	-85.395960	198.	12
027	N3L09S11	30-JUL-1998	09:13:20	28.508450	-85.235897	161.	12
028	N3L09S09	30-JUL-1998	11:04:39	28.625452	-85.044378	98.	12
029	N3L09S07	30-JUL-1998	13:49:16	28.838727	-84.693840	46.	4
030	N3L09S05	30-JUL-1998	17:07:03	29.104373	-84.255880	27.	4
031	N3L09S03	30-JUL-1998	20:19:08	29.341822	-83.860818	19.	4
032	N3L09S01	30-JUL-1998	22:50:28	29.531430	-83.570333	8.	4
033	N3L08S01	31-JUL-1998	06:12:29	29.621713	-84.785898	8.	4
034	N3L08S03	31-JUL-1998	08:36:50	29.403607	-84.995545	21.	4
035	N3L08S05	31-JUL-1998	11:16:16	29.205245	-85.272588	37.	4
036	N3L08S07	31-JUL-1998	14:11:29	28.975060	-85.535807	140.	12
037	N3L08S09	31-JUL-1998	16:14:36	28.824595	-85.717203	197.	11
038	N3L08S11	31-JUL-1998	19:17:29	28.604903	-85.976282	307.	12
039	N3L08S13	31-JUL-1998	22:14:27	28.400148	-86.216572	501.	12
040	N3L08S15	31-JUL-1998	23:54:13	28.292012	-86.340175	693.	12
041	N3L08S17	01-AUG-1998	02:09:26	28.137015	-86.525497	992.	12
042	N3L07S17	01-AUG-1998	06:52:52	28.375943	-86.981068	990.	12
043	N3L07S15	01-AUG-1998	09:40:12	28.559653	-86.772890	667.	12
044	N3L07S13	01-AUG-1998	11:44:04	28.701435	-86.612580	499.	12
045	N3L07S11	01-AUG-1998	13:55:59	28.863668	-86.421413	381.	12
046	N3L07S09	01-AUG-1998	15:51:39	29.016475	-86.243885	316.	11
047	N3L07S07	01-AUG-1998	18:19:53	29.207175	-86.027013	200.	12
048	N3L07S05	01-AUG-1998	20:05:19	29.295125	-85.924100	108.	12
049	N3L07S03	01-AUG-1998	22:29:28	29.499958	-85.694067	32.	4
050	N3L07S01	02-AUG-1998	00:34:14	29.686640	-85.479528	21.	6
051	N3L07S00	02-AUG-1998	01:29:37	29.748238	-85.411762	9.	4
052	N3L06S01	02-AUG-1998	05:35:17	30.180618	-85.886553	21.	4
053	N3L06S03	02-AUG-1998	07:10:57	30.019123	-86.026305	33.	5
054	N3L06S05	02-AUG-1998	08:56:45	29.852567	-86.170755	48.	7
055	N3L06S07	02-AUG-1998	10:44:56	29.688697	-86.311607	100.	12
056	N3L06S09	02-AUG-1998	13:26:53	29.501940	-86.473453	202.	12
057	N3L06S11	02-AUG-1998	15:48:02	29.315217	-86.631220	383.	12
058	N3L06S13	02-AUG-1998	18:26:24	29.132113	-86.786168	496.	12
059	N3L06S15	02-AUG-1998	21:02:09	28.982292	-86.914093	608.	11
060	N3L06S17	02-AUG-1998	23:11:44	28.826853	-87.050170	764.	12
061	N3L06S19	03-AUG-1998	01:39:49	28.653187	-87.202818	996.	12
062	N3L05S17	03-AUG-1998	07:15:10	29.059607	-87.206327	994.	12
063	N3L05S15	03-AUG-1998	09:56:50	29.275210	-87.103760	705.	12
064	N3L05S13	03-AUG-1998	12:10:10	29.467830	-87.010633	486.	12
065	N3L05S11	03-AUG-1998	14:03:32	29.608305	-86.943720	263.	12
066	N3L05S09	03-AUG-1998	15:22:42	29.725402	-86.886035	199.	12

Table 3.1.1. Times and locations for CTD stations on cruise N3 (continued).

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
068	N3L05S05	03-AUG-1998	18:59:03	30.028228	-86.737713	101.	7
069	N3L05S03	03-AUG-1998	21:13:09	30.204203	-86.654452	29.	5
070	N3L05S01	03-AUG-1998	22:41:35	30.353147	-86.580325	23.	4
071	N3L04S00	04-AUG-1998	03:10:41	30.299147	-87.345772	9.	4
072	N3L04S01	04-AUG-1998	03:53:50	30.220657	-87.352663	22.	4
073	N3L04S03	04-AUG-1998	05:45:10	29.979935	-87.352592	29.	5
074	N3L04S05	04-AUG-1998	07:45:05	29.729598	-87.352253	77.	6
075	N3L04S07	04-AUG-1998	09:11:48	29.569920	-87.354860	106.	10
076	N3L04S08	04-AUG-1998	10:18:32	29.532568	-87.351640	193.	12
077	N3L04S10	04-AUG-1998	11:54:46	29.376225	-87.332367	507.	12
078	N3L04S12	04-AUG-1998	14:30:36	29.195090	-87.348343	985.	12
079	N3L03S10	04-AUG-1998	20:46:09	29.151810	-87.862398	1024.	12
080	N3L03S09	04-AUG-1998	22:47:27	29.201073	-87.888850	555.	12
081	N3L03S08	05-AUG-1998	00:16:45	29.282653	-87.891170	200.	12
082	N3L03S07	05-AUG-1998	01:08:02	29.339482	-87.886112	101.	8
083	N3L03S05	05-AUG-1998	03:10:33	29.558542	-87.948972	44.	5
084	N3L03S03	05-AUG-1998	04:59:21	29.804210	-87.998702	37.	4
085	N3L03S01	05-AUG-1998	06:52:25	30.019387	-88.042483	23.	4
086	N3L03S00	05-AUG-1998	07:56:34	30.143178	-88.086707	14.	4
087	N3L02S00	05-AUG-1998	12:34:17	29.776778	-88.746118	16.	4
088	N3L02S01	05-AUG-1998	13:34:04	29.660397	-88.692102	20.	4
089	N3L02S03	05-AUG-1998	15:31:44	29.392483	-88.572582	59.	6
090	N3L02S05	05-AUG-1998	17:12:04	29.233090	-88.501800	102.	7
091	N3L02S06	05-AUG-1998	18:15:24	29.173015	-88.472128	191.	12
092	N3L02S08	05-AUG-1998	20:06:52	29.044025	-88.414723	506.	12
093	N3L02S10	05-AUG-1998	22:14:44	28.879717	-88.340558	955.	12
094	N3L01S07	06-AUG-1998	04:57:09	28.663475	-88.901818	1000.	12
095	N3L01S05	06-AUG-1998	06:59:29	28.806370	-88.949907	504.	12
096	N3L01S04	06-AUG-1998	08:33:58	28.897267	-88.975312	198.	12
097	N3L01S03	06-AUG-1998	09:38:20	28.979338	-89.004573	81.	7
098	N3L01S01	06-AUG-1998	10:30:16	29.056893	-89.031138	20.	4
099	N3M0001	06-AUG-1998	16:53:10	28.619875	-89.943740	302.	5

Table 3.1.2 Number of bottles sampled by variable on cruise N3.

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
000	N3TEST04	12	11	12	0	0	0
001	N3L11S18	12	12	12	4	3	2
002	N3L11S16	12	12	0	0	0	0
003	N3L11S14	12	12	0	3	3	2
004	N3L11S12	12	12	0	0	0	0
005	N3L11S10	12	12	0	0	3	2

Table 3.1.2 Number of bottles sampled by variable on cruise N3 (continued).

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
006	N3L11S08	12	12	0	3	3	2
007	N3L11S06	5	5	0	0	0	0
008	N3L11S04	5	5	0	3	3	2
009	N3L11S02	5	5	0	3	3	2
010	N3L11S01	4	4	4	0	0	0
011	N3L10S01	4	4	4	0	0	0
012	N3L10S03	4	4	0	3	3	2
013	N3L10S05	4	4	0	3	3	2
014	N3L10S07	4	4	0	2	3	2
015	N3L10S09	5	5	0	0	0	0
016	N3L10S11	11	11	0	3	3	2
017	N3L10S13	12	12	0	4	3	2
018	N3L10S15	12	12	0	0	0	0
019	N3L10S17	12	12	0	3	3	2
020	N3L10S19	11	11	0	0	0	0
021	N3L10S21	12	12	12	3	3	2
022	N3L09S21	11	11	11	3	2	1
023	N3L09S19	12	12	0	0	0	0
024	N3L09S17	12	12	0	3	3	2
025	N3L09S15	12	12	0	0	0	0
026	N3L09S13	12	12	0	3	3	2
027	N3L09S11	12	12	0	0	0	0
028	N3L09S09	12	12	0	3	3	2
029	N3L09S07	4	4	0	3	3	2
030	N3L09S05	4	4	0	2	3	2
031	N3L09S03	4	4	0	2	3	2
032	N3L09S01	4	4	4	0	0	0
033	N3L08S01	4	4	4	0	0	0
034	N3L08S03	4	4	0	3	3	2
035	N3L08S05	4	4	0	0	0	0
036	N3L08S07	12	12	0	3	3	2
037	N3L08S09	11	11	0	3	3	2
038	N3L08S11	12	12	0	0	0	0
039	N3L08S13	12	12	0	3	3	2
040	N3L08S15	12	12	0	0	0	0
041	N3L08S17	12	12	12	3	3	2
042	N3L07S17	12	12	12	3	3	2
043	N3L07S15	12	12	0	0	0	0
044	N3L07S13	12	12	0	3	3	2
045	N3L07S11	12	12	0	0	0	0
046	N3L07S09	11	11	0	0	0	0
047	N3L07S07	12	12	0	3	4	2
048	N3L07S05	12	12	0	3	4	2
049	N3L07S03	4	4	0	0	0	0
050	N3L07S01	6	6	0	1	3	2
051	N3L07S00	4	4	4	0	0	0
052	N3L06S01	4	4	4	3	3	2
053	N3L06S03	5	5	0	0	0	0

Table 3.1.2 Number of bottles sampled by variable on cruise N3 (continued).

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
054	N3L06S05	7	7	0	0	0	0
055	N3L06S07	12	12	0	4	3	2
056	N3L06S09	12	12	0	3	3	1
057	N3L06S11	12	12	0	0	0	0
058	N3L06S13	12	12	0	2	3	2
059	N3L06S15	11	11	0	0	0	0
060	N3L06S17	12	12	0	0	0	0
061	N3L06S19	12	12	12	3	3	2
062	N3L05S17	12	12	12	3	3	2
063	N3L05S15	12	12	0	0	0	0
064	N3L05S13	12	12	0	3	3	2
065	N3L05S11	12	12	0	0	0	0
066	N3L05S09	12	12	0	3	3	2
067	N3L05S07	12	12	0	0	0	0
068	N3L05S05	7	7	0	3	3	2
069	N3L05S03	5	5	0	0	0	0
070	N3L05S01	4	4	4	2	3	2
071	N3L04S00	4	4	4	0	0	0
072	N3L04S01	4	4	0	2	3	2
073	N3L04S03	5	5	0	0	0	0
074	N3L04S05	6	6	0	0	0	0
075	N3L04S07	10	10	0	3	3	2
076	N3L04S08	12	12	0	0	3	2
077	N3L04S10	12	12	0	3	3	2
078	N3L04S12	12	12	12	3	3	2
079	N3L03S10	12	12	12	3	3	2
080	N3L03S09	12	12	0	3	3	2
081	N3L03S08	12	12	0	2	3	2
082	N3L03S07	8	8	0	3	3	2
083	N3L03S05	5	5	0	0	0	0
084	N3L03S03	4	4	0	0	0	0
085	N3L03S01	4	4	0	3	3	2
086	N3L03S00	4	4	4	0	0	0
087	N3L02S00	4	4	4	0	0	0
088	N3L02S01	4	4	0	3	3	2
089	N3L02S03	6	6	0	0	0	0
090	N3L02S05	7	7	0	2	3	2
091	N3L02S06	12	12	0	2	3	2
092	N3L02S08	12	12	0	3	3	2
093	N3L02S10	12	12	12	3	3	2
094	N3L01S07	12	12	12	3	3	2
095	N3L01S05	12	12	0	3	3	2
096	N3L01S04	12	12	0	3	3	2
097	N3L01S03	7	7	0	6	3	2
098	N3L01S01	4	4	4	3	3	2
099	N3M0001	5	5	5	0	0	0

* POC = particulate organic carbon; PON = particulate organic nitrogen; PM = total particulate material

Table 3.1.3 Launch times and locations for XBT drops on cruise N3.

Sequence Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
001	N3X04051	26-JUL-1998	18:28:34	29.128542	-87.288903	1000.	T-7
002	N3L05S17	26-JUL-1998	19:11:16	29.054498	-87.205215	1000.	T-7
003	N3X05061	26-JUL-1998	20:01:03	28.951487	-87.201157	975.	T-7
004	N3X05062	26-JUL-1998	20:58:59	28.810593	-87.218560	984.	T-7
005	N3L06S19	26-JUL-1998	22:04:35	28.653030	-87.202043	1000.	T-7
006	N3X06071	26-JUL-1998	22:53:18	28.552805	-87.139875	972.	T-7
007	N3X06072	26-JUL-1998	23:43:57	28.448908	-87.063757	996.	T-7
008	N3L07S17	27-JUL-1998	00:26:28	28.376363	-86.982242	1000.	T-7
009	N3X07081	27-JUL-1998	01:28:37	28.303408	-86.842267	1048.	T-7
010	N3X07082	27-JUL-1998	02:40:32	28.226973	-86.666882	913.	T-7
011	N3L08S17	27-JUL-1998	03:46:04	28.135313	-86.519485	1000.	T-7
012	N3X08091	27-JUL-1998	04:46:51	28.072010	-86.371352	1009.	T-7
013	N3X08092	27-JUL-1998	05:46:21	28.033502	-86.224763	1744.	T-7
014	N3L09S21	27-JUL-1998	06:56:36	28.018862	-86.042678	1001.	T-7
015	N3X09101	27-JUL-1998	08:12:15	27.935138	-85.871833	989.	T-7
016	N3X09102	27-JUL-1998	09:12:19	27.865832	-85.733900	989.	T-7
017	N3L10S21	27-JUL-1998	10:05:20	27.782218	-85.631172	996.	T-7
018	N3X10111	27-JUL-1998	11:05:39	27.666353	-85.540715	1092.	T-7
019	N3X10112	27-JUL-1998	11:49:17	27.583952	-85.475033	1071.	T-7
020	N3L11S17	27-JUL-1998	14:24:51	27.499863	-85.294733	836.	T-7
021	N3L11S15	27-JUL-1998	16:25:12	27.499965	-85.145610	630.	T-7
022	N3L11S13	27-JUL-1998	18:33:43	27.499707	-84.985277	388.	T-7
023	N3L11S11	27-JUL-1998	21:21:45	27.499983	-84.791900	235.	T-7
024	N3L11S09	27-JUL-1998	23:33:22	27.499763	-84.523500	138.	T-10
025	N3L11S07	28-JUL-1998	02:30:32	27.500060	-84.159797	70.	T-10
026	N3L11S05	28-JUL-1998	05:28:11	27.500192	-83.732703	51.	T-10
027	N3L11S03	28-JUL-1998	08:48:13	27.500408	-83.149598	25.	T-10
028	N3L10S02	28-JUL-1998	21:14:56	28.559885	-83.186722	16.	T-10
029	N3L10S04	28-JUL-1998	23:41:03	28.456135	-83.528418	26.	T-10
030	N3L10S06	29-JUL-1998	02:05:28	28.342385	-83.882175	35.	T-10
031	N3L10S08	29-JUL-1998	04:36:32	28.227835	-84.240287	49.	T-10
033	N3L10S10	29-JUL-1998	06:58:35	28.120892	-84.568892	76.	T-10
034	N3L10S12	29-JUL-1998	08:50:41	28.048755	-84.799552	150.	T-10
036	N3L10S14	29-JUL-1998	10:30:18	27.990537	-84.980543	251.	T-7
037	N3L10S16	29-JUL-1998	12:14:14	27.930118	-85.167112	394.	T-7
038	N3L10S18	29-JUL-1998	13:58:30	27.877385	-85.333268	560.	T-7
039	N3L10S20	29-JUL-1998	16:30:37	27.813168	-85.517380	763.	T-7
040	N3L09S20	30-JUL-1998	00:29:47	28.073142	-85.951320	808.	T-7
041	N3L09S18	30-JUL-1998	02:26:32	28.163085	-85.801850	557.	T-7
042	N3L09S16	30-JUL-1998	04:59:32	28.254307	-85.652963	377.	T-7
043	N3L09S14	30-JUL-1998	06:50:28	28.361022	-85.479158	242.	T-7
044	N3L09S12	30-JUL-1998	08:30:39	28.457777	-85.318668	179.	T-10
045	N3L09S10	30-JUL-1998	10:15:27	28.566690	-85.137870	130.	T-10
046	N3L09S08	30-JUL-1998	12:28:12	28.725348	-84.882413	52.	T-10
047	N3L09S06	30-JUL-1998	15:28:03	28.972233	-84.475905	34.	T-10
048	N3L09S04	30-JUL-1998	18:53:45	29.231382	-84.052455	26.	T-10

Table 3.1.3 Launch times and locations for XBT drops on cruise N3 (continued).

Sequence Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
049	N3L09S02	30-JUL-1998	21:37:46	29.427417	-83.728827	16.	T-10
050	N3L08S02	31-JUL-1998	07:25:51	29.516995	-84.883372	11.	T-10
051	N3L08S04	31-JUL-1998	09:53:01	29.327487	-85.128430	27.	T-10
052	N3L08S06	31-JUL-1998	12:50:42	29.094085	-85.403232	51.	T-10
053	N3L08S08	31-JUL-1998	15:25:51	28.900722	-85.631332	171.	T-10
054	N3L08S10	31-JUL-1998	18:12:19	28.705287	-85.859580	258.	T-7
055	N3L08S12	31-JUL-1998	21:12:17	28.496383	-86.105008	378.	T-7
056	N3L08S14	31-JUL-1998	23:17:05	28.350663	-86.273215	575.	T-7
058	N3L08S16	01-AUG-1998	01:26:32	28.216790	-86.445618	823.	T-7
059	N3X07083	01-AUG-1998	04:48:28	28.193288	-86.739348	1304.	T-7
060	N3L07S16	01-AUG-1998	08:46:48	28.488048	-86.859977	774.	T-7
061	N3L07S14	01-AUG-1998	11:00:30	28.636128	-86.683467	564.	T-7
062	N3L07S12	01-AUG-1998	13:04:23	28.784893	-86.512747	424.	T-7
063	N3L07S10	01-AUG-1998	15:08:28	28.862688	-86.419637	352.	T-7
065	N3L07S06	01-AUG-1998	19:32:43	29.251218	-85.977020	160.	T-10
066	N3L07S04	01-AUG-1998	21:21:58	29.388545	-85.823043	50.	T-10
067	N3L07S02	01-AUG-1998	23:35:43	29.593712	-85.586452	27.	T-10
068	N3L06S02	02-AUG-1998	06:24:27	30.098108	-85.954990	30.	T-10
069	N3L06S04	02-AUG-1998	08:00:17	29.940802	-86.088962	39.	T-10
070	N3L06S06	02-AUG-1998	10:00:28	29.760210	-86.247113	68.	T-10
071	N3L06S08	02-AUG-1998	12:26:07	29.600152	-86.384920	135.	T-10
073	N3L06S10	02-AUG-1998	14:46:50	29.409880	-86.548825	289.	T-7
074	N3L06S12	02-AUG-1998	17:29:36	29.226262	-86.706575	438.	T-7
075	N3L06S14	02-AUG-1998	20:20:13	29.047830	-86.860465	559.	T-7
076	N3L06S16	02-AUG-1998	22:22:38	28.911722	-86.979190	681.	T-7
077	N3L06S18	03-AUG-1998	00:45:00	28.742548	-87.124970	761.	T-7
078	N3L05S18	03-AUG-1998	03:59:36	28.817380	-87.351317	1279.	T-7
079	N3L05S16	03-AUG-1998	09:08:22	29.181633	-87.148533	823.	T-7
080	N3L05S14	03-AUG-1998	11:22:03	29.374378	-87.055072	613.	T-7
081	N3L05S12	03-AUG-1998	13:25:43	29.534155	-86.977733	346.	T-7
082	N3L05S10	03-AUG-1998	14:52:20	29.671867	-86.913882	221.	T-7
083	N3L05S08	03-AUG-1998	16:41:59	29.808145	-86.846108	167.	T-10
084	N3L05S06	03-AUG-1998	18:24:12	29.959968	-86.773190	123.	T-10
085	N3L05S04	03-AUG-1998	20:28:15	30.111905	-86.699738	47.	T-10
086	N3L05S02	03-AUG-1998	22:03:49	30.204203	-86.654452	28.	T-10
087	N3L04S02	04-AUG-1998	04:46:51	30.102758	-87.351113	29.	T-10
088	N3L04S04	04-AUG-1998	06:45:25	29.856718	-87.351235	46.	T-10
089	N3L04S06	04-AUG-1998	08:29:03	29.656727	-87.350628	80.	T-10
090	N3L04S09	04-AUG-1998	11:16:26	29.449588	-87.350223	360.	T-7
092	N3L04S11	04-AUG-1998	13:48:22	29.275227	-87.355148	779.	T-7
093	N3X03042	04-AUG-1998	16:34:25	29.238290	-87.494077	943.	T-7
094	N3X03051	04-AUG-1998	18:02:47	29.127193	-87.600058	1284.	T-7
096	N3X03041	04-AUG-1998	19:25:43	29.198075	-87.702525	1038.	T-7
097	N3L03S06	05-AUG-1998	02:26:25	29.453147	-87.927437	62.	T-10
098	N3L03S04	05-AUG-1998	04:05:44	29.678190	-87.972005	40.	T-10
099	N3L03S02	05-AUG-1998	06:04:31	29.912645	-88.014382	34.	T-10

Table 3.1.3 Launch times and locations for XBT drops on cruise N3 (continued).

Sequence Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
100	N3L02S02	05-AUG-1998	14:30:03	29.538337	-88.636545	30.	T-10
101	N3L02S04	05-AUG-1998	16:25:55	29.316452	-88.536933	65.	T-10
102	N3L02S07	05-AUG-1998	19:22:47	29.122027	-88.451720	293.	T-10
103	N3L02S09	05-AUG-1998	21:36:10	28.955270	-88.377165	881.	T-7
104	N3X01022	06-AUG-1998	00:45:25	28.798690	-88.556007	1024.	T-7
105	N3X01021	06-AUG-1998	01:59:36	28.742565	-88.758103	994.	T-7
106	N3X01023	06-AUG-1998	03:55:34	28.590807	-88.747148	1284.	T-7
109	N3L01S06	06-AUG-1998	06:25:17	28.744000	-88.926665	734.	T-7
110	N3L01S02	06-AUG-1998	10:08:09	29.017445	-89.017360	55.	T-10

Launches at missing sequence numbers were failures or deemed bad data during QA/QC, except numbers 32 and 72, which had no XBT launch although the counter advanced.

3.1.2 Cruise N4

The fourth NEGOM-COH hydrography cruise (N4) was conducted aboard the *R/V Gyre* 13-24 November 1998. It was staged out of Gulfport, MS, and returned to Galveston, TX. Dr. Douglas C. Biggs and Dr. Norman L. Guinasso, Jr., were co-chief scientists. Ninety-nine CTD stations, including one test station, were completed and 122 XBT drops were made. The CTD and XBT locations and the cruise track are shown in Figure 3.1.2. The test station was taken approximately at the location of the seawardmost CTD station on line 4. The cruise track starts at this location and runs along the 1000-m isobath to the seawardmost station on line 11 where the CTD/XBT station series began. XBTs were dropped along this 1000-m track. Only the locations of the 112 successful XBT drops are shown in Figure 3.1.2. Station number, date, time, location, water depth, and number of bottles tripped at each CTD station are shown in Table 3.1.4.

Stations at which bottle samples were taken are summarized in Table 3.1.5. Nutrient and oxygen concentrations were measured from every Niskin bottle depth sampled. Salinity was measured at all bottles only at the most shoreward and most offshore stations and at the test station for a total of 23 stations. Pigment measurements were collected at the top bottle, the chlorophyll-maximum as determined by the downcast fluorescence trace, and the low light regime immediately below the chlorophyll-maximum at 59 stations. PM, POC, and PON were measured from the top and bottom bottles and, for PM, from a middle, "clear water" bottle at 60 stations.

Location, date, time, total water depth, and probe type of the 112 successful XBT drops are listed in Table 3.1.6. Due to instrument malfunction, continuous ADCP data were collected

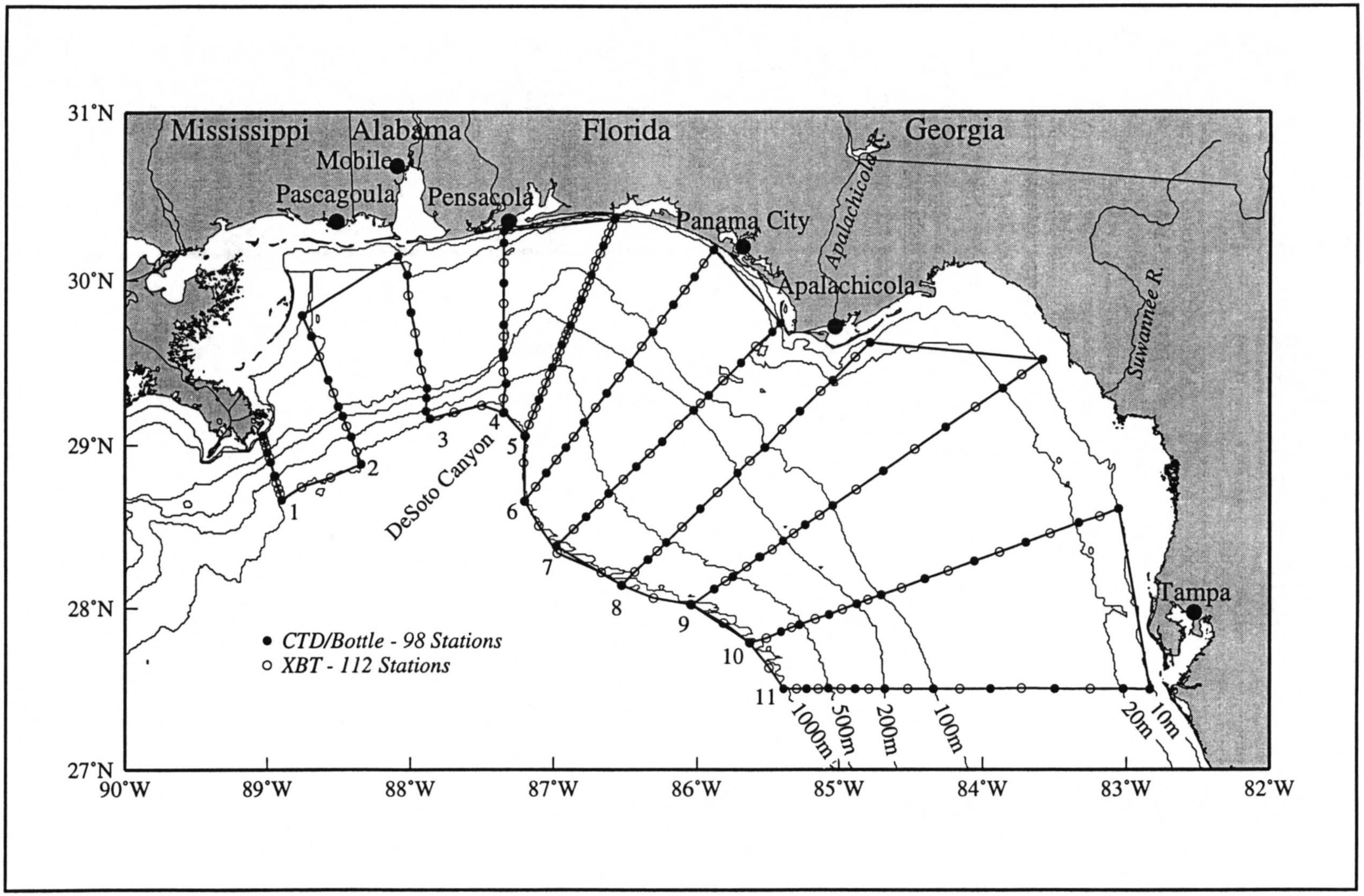


Figure 3.1.2. Station locations for cruise N4 conducted 13 -24 November 1998. CTD stations began with the most seaward station on line 11. The thick line shows the cruise track, which began at the location of the most seaward station on line 4.

only along the survey tracks of lines 1 through 4 (Section 3.2.3). Flow-through, near-surface temperature, conductivity, and fluorescence were logged every 2 min (Section 3.2.5). Surface samples were analyzed for chlorophyll *a* to calibrate the flow-through fluorometer at 108 locations.

Five complementary research efforts were accommodated on autumn cruise N4. Twenty-four ARGOS-tracked drifters were launched for Dr. James M. Price of MMS. A marine mammal survey was conducted by Joel Ortega-Ortiz, Elizabeth Zuniga, and Todd Speakman, graduate students at TAMU-Galveston. The data from this and the three previous surveys will be the basis for Mr. Ortega-Ortiz's Ph.D. dissertation. Plankton net tows were made at the 12 stations closest to the moored upward-looking ADCP current meters in DeSoto Canyon for Rebecca Scott's M.S. thesis research on correlation of standing stocks of zooplankton and micronekton with volume backscatter from moored ADCPs. Dr. Caesar Fuentes-Vaco and Mr. Joe Vanderbloemen of the USF Remote Sensing Laboratory continued the USF bio-optical measurements of downwelling and sea-leaving radiance. For this "sea truth" for the SeaWiFS satellite receiver, they made vertical profiles twice daily about 1000-1100 and 1400-1600 local time, using USF's multichannel Marine Environmental Radiometer. They also used a WetLabs AC-9 bio-optical profiler for an underway survey of wavelength-specific absorbance. This instrument measures the absorbance spectrum (action spectrum) of chlorophylls and accessory pigments in the same nine wavelength bands being monitored by the SeaWiFS satellite in low earth orbit. The mooring that Ms. Cheryl Burden, TAMU, had deployed during N3 in Mississippi Canyon was successfully recovered on the transit back to Galveston at the end of N4. Further information on these complementary research programs can be obtained from the scientists involved.

Table 3.1.4. Times and positions for CTD stations on cruise N4.

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
000	N4TEST04	13-NOV-1998	18:40:28	29.195558	-87.349935	986.	12
001	N4L11S18	14-NOV-1998	17:29:10	27.499188	-85.393045	996.	10
002	N4L11S16	14-NOV-1998	19:53:42	27.500687	-85.225825	754.	12
003	N4L11S14	14-NOV-1998	21:39:45	27.501593	-85.075830	495.	12
004	N4L11S12	14-NOV-1998	23:29:17	27.500265	-84.889595	298.	11
005	N4L11S10	15-NOV-1998	01:26:32	27.499510	-84.681945	202.	12
006	N4L11S08	15-NOV-1998	04:00:42	27.500248	-84.343957	102.	12
007	N4L11S06	15-NOV-1998	06:59:06	27.499490	-83.944130	58.	4
008	N4L11S04	15-NOV-1998	10:06:06	27.501452	-83.497440	43.	4
009	N4L11S02	15-NOV-1998	13:13:58	27.500517	-83.023298	22.	4
010	N4L11S01	15-NOV-1998	14:36:00	27.497833	-82.837300	13.	3
011	N4L10S01	15-NOV-1998	23:13:29	28.607022	-83.056033	11.	4
012	N4L10S03	16-NOV-1998	01:19:17	28.522183	-83.329223	21.	4

Table 3.1.4. Times and positions for CTD stations on cruise N4 (continued).

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
013	N4L10S05	16-NOV-1998	04:05:15	28.400337	-83.701557	32.	6
014	N4L10S07	16-NOV-1998	06:44:45	28.285638	-84.058747	39.	5
015	N4L10S09	16-NOV-1998	09:13:58	28.177663	-84.403115	60.	6
016	N4L10S11	16-NOV-1998	11:36:49	28.078403	-84.706477	100.	12
017	N4L10S13	16-NOV-1998	13:13:11	28.023447	-84.877337	200.	12
018	N4L10S15	16-NOV-1998	15:08:19	27.959290	-85.071193	313.	12
019	N4L10S17	16-NOV-1998	17:09:14	27.895093	-85.277087	496.	12
020	N4L10S19	16-NOV-1998	18:49:55	27.852677	-85.412360	655.	12
021	N4L10S21	16-NOV-1998	21:18:31	27.784385	-85.629952	989.	12
022	N4L09S21	17-NOV-1998	02:03:28	28.018665	-86.042477	994.	12
023	N4L09S19	17-NOV-1998	04:22:46	28.115573	-85.876378	681.	12
024	N4L09S17	17-NOV-1998	06:14:33	28.189903	-85.752475	505.	12
025	N4L09S15	17-NOV-1998	08:33:01	28.311012	-85.562162	304.	12
026	N4L09S13	17-NOV-1998	10:32:39	28.409955	-85.395780	201.	12
027	N4L09S11	17-NOV-1998	12:21:30	28.508060	-85.236110	164.	12
028	N4L09S09	17-NOV-1998	14:22:02	28.626885	-85.044172	98.	6
029	N4L09S07	17-NOV-1998	17:15:41	28.838068	-84.693530	46.	6
030	N4L09S05	17-NOV-1998	21:31:51	29.104647	-84.257842	28.	7
031	N4L09S03	18-NOV-1998	00:55:00	29.341840	-83.860275	20.	5
032	N4L09S01	18-NOV-1998	03:12:26	29.517672	-83.583102	10.	4
033	N4L08S01	18-NOV-1998	10:32:50	29.621488	-84.786358	8.	3
034	N4L08S03	18-NOV-1998	12:59:56	29.391728	-85.043183	22.	5
035	N4L08S05	18-NOV-1998	15:08:24	29.203762	-85.273923	40.	6
036	N4L08S07	18-NOV-1998	17:37:25	28.983717	-85.530202	136.	12
037	N4L08S09	18-NOV-1998	20:11:33	28.825705	-85.718520	199.	12
038	N4L08S11	18-NOV-1998	23:00:34	28.605965	-85.976177	309.	12
039	N4L08S13	19-NOV-1998	01:34:39	28.402092	-86.213295	496.	12
040	N4L08S15	19-NOV-1998	03:20:50	28.296498	-86.340252	672.	12
041	N4L08S17	19-NOV-1998	05:39:35	28.139142	-86.525590	978.	12
042	N4L07S17	19-NOV-1998	11:00:18	28.378317	-86.983005	991.	12
043	N4L07S15	19-NOV-1998	13:45:16	28.558288	-86.775057	669.	12
044	N4L07S13	19-NOV-1998	15:51:19	28.701112	-86.613103	500.	12
045	N4L07S11	19-NOV-1998	18:05:37	28.864333	-86.421905	381.	12
046	N4L07S09	19-NOV-1998	20:21:01	29.017880	-86.245900	316.	12
047	N4L07S07	19-NOV-1998	22:41:05	29.209330	-86.027185	200.	12
048	N4L07S05	19-NOV-1998	23:59:11	29.300757	-85.917322	88.	12
049	N4L07S03	20-NOV-1998	02:07:53	29.500063	-85.693453	32.	6
050	N4L07S01	20-NOV-1998	04:13:22	29.686317	-85.478558	21.	4
051	N4L07S00	20-NOV-1998	05:08:12	29.739055	-85.418357	11.	3
052	N4L06S01	20-NOV-1998	09:33:09	30.179043	-85.884057	21.	4
053	N4L06S03	20-NOV-1998	11:10:12	30.018510	-86.022023	32.	5
054	N4L06S05	20-NOV-1998	12:47:33	29.851515	-86.166228	47.	6
055	N4L06S07	20-NOV-1998	14:24:36	29.686430	-86.312373	100.	12
056	N4L06S09	20-NOV-1998	16:42:10	29.500223	-86.471882	203.	12
057	N4L06S11	20-NOV-1998	19:05:50	29.314793	-86.630258	382.	12
058	N4L06S13	20-NOV-1998	21:32:05	29.134022	-86.788912	498.	12
059	N4L06S15	20-NOV-1998	23:34:15	28.983260	-86.915318	610.	12

Table 3.1.4. Times and positions for CTD stations on cruise N4 (continued).

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
060	N4L06S17	21-NOV-1998	01:33:45	28.827043	-87.052378	768.	12
061	N4L06S19	21-NOV-1998	03:47:56	28.653253	-87.202562	999.	12
062	N4L05S17	21-NOV-1998	07:20:37	29.054417	-87.205243	997.	12
063	N4L05S15	21-NOV-1998	09:59:21	29.273453	-87.105488	709.	12
064	N4L05S13	21-NOV-1998	12:19:15	29.468407	-87.012885	480.	12
065	N4L05S11	21-NOV-1998	14:30:50	29.610092	-86.943343	261.	12
066	N4L05S09	21-NOV-1998	15:53:03	29.724592	-86.885620	199.	12
067	N4L05S07	21-NOV-1998	17:50:00	29.881287	-86.811973	148.	12
068	N4L05S05	21-NOV-1998	19:21:36	30.028600	-86.739370	100.	12
069	N4L05S03	21-NOV-1998	21:13:08	30.204423	-86.656528	31.	5
070	N4L05S01	21-NOV-1998	22:38:55	30.365618	-86.579485	20.	4
071	N4L04S00	22-NOV-1998	06:38:44	30.294032	-87.353068	8.	2
072	N4L04S01	22-NOV-1998	07:22:35	30.221478	-87.353522	21.	4
073	N4L04S03	22-NOV-1998	09:21:07	29.978903	-87.353180	30.	4
074	N4L04S05	22-NOV-1998	11:27:56	29.729947	-87.351290	77.	6
075	N4L04S07	22-NOV-1998	13:03:13	29.567627	-87.354602	104.	12
076	N4L04S08	22-NOV-1998	14:05:55	29.530745	-87.350418	218.	12
077	N4L04S10	22-NOV-1998	15:47:59	29.373837	-87.333593	514.	12
078	N4L04S12	22-NOV-1998	18:24:39	29.193152	-87.352120	1001.	12
079	N4L03S10	22-NOV-1998	23:40:13	29.157167	-87.864602	971.	12
080	N4L03S09	23-NOV-1998	01:32:52	29.202467	-87.891375	524.	12
081	N4L03S08	23-NOV-1998	02:51:26	29.284967	-87.890168	192.	12
082	N4L03S07	23-NOV-1998	03:53:16	29.344007	-87.884107	95.	12
083	N4L03S05	23-NOV-1998	06:13:31	29.559247	-87.948640	42.	6
084	N4L03S03	23-NOV-1998	08:40:06	29.803355	-87.999593	37.	5
085	N4L03S01	23-NOV-1998	10:47:28	30.029165	-88.025323	21.	5
086	N4L03S00	23-NOV-1998	11:56:57	30.143037	-88.088907	14.	3
087	N4L02S00	23-NOV-1998	16:51:53	29.787698	-88.753917	15.	3
088	N4L02S01	23-NOV-1998	17:59:31	29.660398	-88.691945	19.	5
089	N4L02S03	23-NOV-1998	20:25:31	29.393723	-88.574518	58.	7
090	N4L02S05	23-NOV-1998	21:56:54	29.231942	-88.503993	102.	12
091	N4L02S06	23-NOV-1998	22:59:52	29.175060	-88.473368	188.	12
092	N4L02S08	24-NOV-1998	00:32:37	29.047563	-88.415242	492.	12
093	N4L02S10	24-NOV-1998	02:40:14	28.879962	-88.340457	969.	12
094	N4L01S07	24-NOV-1998	07:46:56	28.663585	-88.900753	997.	12
095	N4L01S05	24-NOV-1998	09:52:30	28.805485	-88.948545	503.	12
096	N4L01S04	24-NOV-1998	11:18:56	28.895372	-88.976230	202.	12
097	N4L01S03	24-NOV-1998	12:18:45	28.952748	-88.999563	102.	12
098	N4L01S01	24-NOV-1998	13:34:36	29.058608	-89.030117	19.	4

Table 3.1.5 Number of bottles sampled by variable on cruise N4.

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
000	N4TEST04	12	23	12	0	0	0
001	N4L11S18	10	10	10	3	3	2
002	N4L11S16	12	12	0	0	0	0
003	N4L11S14	12	12	0	3	3	2
004	N4L11S12	11	11	0	0	0	0
005	N4L11S10	12	12	0	3	3	2
006	N4L11S08	12	12	0	3	3	2
007	N4L11S06	4	4	0	0	0	0
008	N4L11S04	4	4	0	2	3	2
009	N4L11S02	4	4	0	2	2	2
010	N4L11S01	3	3	3	0	0	0
011	N4L10S01	4	4	4	0	0	0
012	N4L10S03	4	4	0	2	3	2
013	N4L10S05	6	6	0	2	3	2
014	N4L10S07	5	5	0	0	3	2
015	N4L10S09	6	6	0	0	0	0
016	N4L10S11	12	12	0	0	3	2
017	N4L10S13	12	12	0	3	3	2
018	N4L10S15	12	12	0	0	0	0
019	N4L10S17	12	12	0	3	3	2
020	N4L10S19	12	12	0	0	0	0
021	N4L10S21	12	12	12	3	3	2
022	N4L09S21	12	12	12	3	3	2
023	N4L09S19	12	12	0	0	0	0
024	N4L09S17	12	12	0	3	3	2
025	N4L09S15	12	12	0	0	0	0
026	N4L09S13	12	12	0	3	3	2
027	N4L09S11	12	12	0	0	0	0
028	N4L09S09	6	6	0	3	3	2
029	N4L09S07	6	6	0	3	3	2
030	N4L09S05	7	7	0	3	3	2
031	N4L09S03	5	5	0	2	3	2
032	N4L09S01	4	4	4	2	0	0
033	N4L08S01	3	3	3	0	0	0
034	N4L08S03	5	5	0	3	3	2
035	N4L08S05	6	6	0	0	0	0
036	N4L08S07	12	12	0	3	3	2
037	N4L08S09	12	12	0	3	3	2
038	N4L08S11	12	12	0	0	0	0
039	N4L08S13	12	12	0	3	3	2
040	N4L08S15	12	12	0	0	0	0
041	N4L08S17	12	12	12	3	3	2
042	N4L07S17	12	12	12	3	3	2
043	N4L07S15	12	12	0	0	0	0
044	N4L07S13	12	12	0	3	3	2
045	N4L07S11	12	12	0	0	0	0

Table 3.1.5 Number of bottles sampled by variable on cruise N4 (continued).

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
046	N4L07S09	12	12	0	0	0	0
047	N4L07S07	12	12	0	3	3	2
048	N4L07S05	12	12	0	3	3	2
049	N4L07S03	6	6	0	0	0	0
050	N4L07S01	4	4	0	2	3	2
051	N4L07S00	3	3	3	0	0	0
052	N4L06S01	4	4	4	2	3	2
053	N4L06S03	5	5	0	0	0	0
054	N4L06S05	6	6	0	0	0	0
055	N4L06S07	11	12	0	3	3	2
056	N4L06S09	12	12	0	3	3	2
057	N4L06S11	12	12	0	0	0	0
058	N4L06S13	12	12	0	3	3	2
059	N4L06S15	12	12	0	0	0	0
060	N4L06S17	12	12	0	0	0	0
061	N4L06S19	12	12	12	3	3	2
062	N4L05S17	12	12	12	3	3	2
063	N4L05S15	12	12	0	0	0	0
064	N4L05S13	12	12	0	3	3	2
065	N4L05S11	12	12	0	0	0	0
066	N4L05S09	12	12	0	3	3	2
067	N4L05S07	12	12	0	0	0	0
068	N4L05S05	12	12	0	3	3	2
069	N4L05S03	5	5	0	0	0	0
070	N4L05S01	4	4	4	2	3	2
071	N4L04S00	2	2	2	0	0	0
072	N4L04S01	4	4	0	3	3	2
073	N4L04S03	4	4	0	0	0	0
074	N4L04S05	6	5	0	0	0	0
075	N4L04S07	12	12	0	3	3	2
076	N4L04S08	12	12	0	3	3	2
077	N4L04S10	12	11	0	3	3	2
078	N4L04S12	12	12	12	3	3	2
079	N4L03S10	12	12	12	3	3	2
080	N4L03S09	12	12	0	3	3	2
081	N4L03S08	12	12	0	2	3	2
082	N4L03S07	12	12	0	3	3	2
083	N4L03S05	6	6	0	0	0	0
084	N4L03S03	5	5	0	0	0	0
085	N4L03S01	5	5	0	3	3	2
086	N4L03S00	3	3	3	0	0	0
087	N4L02S00	3	3	3	0	0	0
088	N4L02S01	5	5	0	2	2	2
089	N4L02S03	7	7	0	0	0	0
090	N4L02S05	12	12	0	3	3	2
091	N4L02S06	12	12	0	3	3	2

Table 3.1.5 Number of bottles sampled by variable on cruise N4 (continued).

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
092	N4L02S08	12	12	0	3	3	2
093	N4L02S10	12	12	12	3	3	2
094	N4L01S07	12	12	12	3	3	2
095	N4L01S05	12	12	0	3	3	2
096	N4L01S04	12	12	0	2	3	2
097	N4L01S03	12	12	0	2	3	2
098	N4L01S01	4	4	4	2	3	2

* PM = total particulate material; POC = particulate organic carbon; PON = particulate organic nitrogen

Table 3.1.6 Launch times and locations for XBT drops on cruise N4.

Sequence Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
001	N4L05S17	13-NOV-1998	21:27:56	29.051453	-87.200103	997.	T-7
002	N4X0506M	13-NOV-1998	22:50:36	28.888602	-87.210342	1324.	T-7
003	N4L06S19	14-NOV-1998	00:41:52	28.652912	-87.202508	1001.	T-7
004	N4X0607M	14-NOV-1998	02:04:57	28.501637	-87.102462	967.	T-7
005	N4L07S17	14-NOV-1998	03:30:41	28.334495	-86.975843	1048.	T-7
006	N4X0708M	14-NOV-1998	07:16:43	28.216532	-86.668467	1019.	T-7
007	N4L08S17	14-NOV-1998	08:21:43	28.138928	-86.524803	991.	T-7
008	N4X0809M	14-NOV-1998	09:54:49	28.058220	-86.303430	1006.	T-7
009	N4L09S21	14-NOV-1998	11:34:58	28.019368	-86.042663	998.	T-7
010	N4X0910M	14-NOV-1998	13:15:37	27.905900	-85.814612	992.	T-7
011	N4L10S21	14-NOV-1998	14:46:43	27.782853	-85.630730	1015.	T-7
012	N4X1011M	14-NOV-1998	16:13:04	27.627328	-85.500132	1156.	T-7
013	N4L11S17	14-NOV-1998	19:20:15	27.500167	-85.294667	835.	T-7
014	N4L11S15	14-NOV-1998	21:08:23	27.500033	-85.145808	624.	T-7
015	N4L11S13	14-NOV-1998	22:48:48	27.499995	-84.985853	391.	T-7
016	N4L11S11	15-NOV-1998	00:39:54	27.499772	-84.791605	235.	T-7
017	N4L11S09	15-NOV-1998	02:50:31	27.499770	-84.523337	138.	T-10
018	N4L11S07	15-NOV-1998	05:29:37	27.499973	-84.159748	70.	T-10
019	N4L11S05	15-NOV-1998	08:33:59	27.503267	-83.730715	40.	T-10
020	N4L11S03	15-NOV-1998	11:45:44	27.499905	-83.149712	34.	T-10
021	N4L10S02	16-NOV-1998	00:15:46	28.559937	-83.186537	16.	T-10
022	N4L10S04	16-NOV-1998	02:51:36	28.455878	-83.528225	26.	T-10
023	N4L10S06	16-NOV-1998	05:31:26	28.342523	-83.882147	36.	T-10
024	N4L10S08	16-NOV-1998	08:04:48	28.227573	-84.240312	49.	T-10
025	N4L10S10	16-NOV-1998	10:33:30	28.122690	-84.567622	74.	T-10
026	N4L10S12	16-NOV-1998	12:36:25	28.048803	-84.799285	149.	T-10

Table 3.1.6 Launch times and locations for XBT drops on cruise N4 (continued).

Sequence Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
027	N4L10S14	16-NOV-1998	14:17:19	27.991400	-84.976102	248.	T-7
028	N4L10S16	16-NOV-1998	16:16:47	27.930648	-85.167167	391.	T-7
029	N4L10S18	16-NOV-1998	18:08:49	27.877398	-85.333218	564.	T-7
030	N4L10S20	16-NOV-1998	20:22:48	27.812882	-85.517523	789.	T-7
032	N4L09S18	17-NOV-1998	05:44:44	28.165895	-85.798737	554.	T-7
033	N4L09S16	17-NOV-1998	07:43:01	28.253497	-85.651273	376.	T-7
034	N4L09S14	17-NOV-1998	09:45:28	28.359870	-85.478398	242.	T-7
035	N4L09S12	17-NOV-1998	11:36:34	28.457990	-85.318902	177.	T-10
036	N4L09S10	17-NOV-1998	13:32:24	28.567338	-85.138578	130.	T-10
037	N4L09S08	17-NOV-1998	15:44:58	28.723967	-84.881628	51.	T-10
038	N4L09S06	17-NOV-1998	19:45:19	28.971638	-84.475792	35.	T-10
039	N4L09S04	17-NOV-1998	23:23:31	29.230332	-84.051905	25.	T-10
040	N4L09S02	18-NOV-1998	02:02:07	29.427802	-83.728225	16.	T-10
041	N4L08S02	18-NOV-1998	11:27:27	29.533032	-84.887430	15.	T-10
042	N4L08S04	18-NOV-1998	13:48:52	29.327933	-85.127905	27.	T-10
043	N4L08S06	18-NOV-1998	16:23:40	29.094000	-85.403107	50.	T-10
044	N4L08S08	18-NOV-1998	19:20:31	28.901185	-85.628572	171.	T-10
045	N4L08S10	18-NOV-1998	21:52:18	28.709730	-85.854008	257.	T-7
046	N4L08S12	19-NOV-1998	00:31:31	28.496517	-86.104368	377.	T-7
047	N4L08S14	19-NOV-1998	02:42:40	28.347338	-86.277458	579.	T-7
048	N4L08S16	19-NOV-1998	04:48:25	28.220515	-86.433368	830.	T-7
049	N4L07S16	19-NOV-1998	12:55:20	28.481910	-86.860967	778.	T-7
050	N4L07S14	19-NOV-1998	15:10:30	28.635562	-86.683107	568.	T-7
051	N4L07S12	19-NOV-1998	17:12:53	28.785827	-86.513977	426.	T-7
053	N4L07S10	19-NOV-1998	19:34:58	28.945643	-86.330227	341.	T-7
054	N4L07S08	19-NOV-1998	21:50:50	29.121622	-86.128088	257.	T-7
055	N4L07S06	19-NOV-1998	23:26:23	29.251247	-85.978628	156.	T-10
056	N4L07S04	20-NOV-1998	01:01:48	29.390873	-85.819592	49.	T-10
057	N4L07S02	20-NOV-1998	03:13:42	29.599240	-85.589752	28.	T-10
058	N4L06S02	20-NOV-1998	10:25:19	30.098537	-85.954987	30.	T-10
059	N4L06S04	20-NOV-1998	11:57:42	29.942285	-86.090355	40.	T-10
060	N4L06S06	20-NOV-1998	13:42:45	29.759522	-86.246462	67.	T-10
061	N4L06S08	20-NOV-1998	15:47:20	29.600135	-86.385422	133.	T-10
062	N4L06S10	20-NOV-1998	18:11:39	29.410135	-86.549065	289.	T-7
063	N4L06S12	20-NOV-1998	20:39:57	29.225410	-86.707590	440.	T-7
064	N4L06S14	20-NOV-1998	22:55:40	29.048713	-86.861013	561.	T-7
065	N4L06S16	21-NOV-1998	00:49:16	28.908973	-86.982213	678.	T-7
066	N4L06S18	21-NOV-1998	03:00:59	29.742583	-87.125000	834.	T-7
067	N4L05S16	21-NOV-1998	08:44:14	29.121247	-87.175728	936.	T-7
068	N4L05S16	21-NOV-1998	09:11:20	29.181695	-87.149200	825.	T-7
069	N4L05S15	21-NOV-1998	09:32:06	29.227092	-87.127435	769.	T-7
070	N4L05S14	21-NOV-1998	11:07:00	29.324433	-87.077803	654.	T-7
071	N4L05S14	21-NOV-1998	11:30:27	29.374575	-87.056032	615.	T-7
072	N4L05S13	21-NOV-1998	11:55:11	29.427335	-87.029223	559.	T-7
075	N4L05S12	21-NOV-1998	13:36:23	29.505705	-86.979567	391.	T-7

Table 3.1.6 Launch times and locations for XBT drops on cruise N4 (continued).

Sequence Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
076	N4L05S12	21-NOV-1998	13:50:21	29.534910	-86.978842	342.	T-7
077	N4L05S11	21-NOV-1998	14:08:10	29.570957	-86.960240	295.	T-7
078	N4L05S10	21-NOV-1998	15:06:11	29.635217	-86.930740	242.	T-7
080	N4L05S10	21-NOV-1998	15:22:46	29.670008	-86.913655	221.	T-7
081	N4L05S09	21-NOV-1998	15:35:38	29.697105	-86.900238	209.	T-7
082	N4L05S08	21-NOV-1998	16:50:01	29.763163	-86.868973	184.	T-10
083	N4L05S08	21-NOV-1998	17:10:44	29.806645	-86.847918	164.	T-10
084	N4L05S07	21-NOV-1998	17:27:26	29.843128	-86.831553	159.	T-10
085	N4L05S06	21-NOV-1998	18:27:16	29.918045	-86.794725	135.	T-10
086	N4L05S06	21-NOV-1998	18:46:03	29.959785	-86.774023	123.	T-10
087	N4L05S05	21-NOV-1998	19:02:15	29.996123	-86.756542	111.	T-10
088	N4L05S04	21-NOV-1998	20:11:48	30.078303	-86.721527	63.	T-10
089	N4L05S04	21-NOV-1998	20:27:34	30.115220	-86.707953	46.	T-10
091	N4L05S03	21-NOV-1998	20:48:20	30.160305	-86.678328	32.	T-10
092	N4L05S02	21-NOV-1998	21:41:07	30.242047	-86.637325	24.	T-10
093	N4L05S02	21-NOV-1998	21:59:18	30.283565	-86.618037	28.	T-10
094	N4L05S01	21-NOV-1998	22:17:18	30.324363	-86.596913	26.	T-10
095	N4L04S02	22-NOV-1998	08:21:15	30.102637	-87.350020	30.	T-10
096	N4L04S04	22-NOV-1998	10:25:28	29.856763	-87.350582	45.	T-10
097	N4L04S06	22-NOV-1998	12:18:52	29.656828	-87.350930	79.	T-10
099	N4L04S09	22-NOV-1998	15:09:47	29.445092	-87.351392	364.	T-7
100	N4L04S11	22-NOV-1998	17:31:44	29.281758	-87.350035	838.	T-7
101	N4X03042	22-NOV-1998	20:55:54	29.240618	-87.504847	974.	T-7
102	N4X03041	22-NOV-1998	22:16:39	29.195815	-87.697765	984.	T-7
104	N4L03S06	23-NOV-1998	05:17:00	29.452995	-87.927002	61.	T-10
105	N4L03S04	23-NOV-1998	07:30:59	29.678728	-87.970727	31.	T-10
106	N4L03S02	23-NOV-1998	09:46:18	29.905343	-88.017867	33.	T-10
107	N4L02S02	23-NOV-1998	19:03:28	29.538590	-88.636378	28.	T-10
108	N4L02S04	23-NOV-1998	21:13:07	29.316132	-88.537893	64.	T-10
110	N4L02S07	23-NOV-1998	23:55:12	29.111210	-88.446407	320.	T-7
111	N4L02S09	24-NOV-1998	02:01:43	28.955310	-88.377638	881.	T-7
113	N4X01022	24-NOV-1998	05:18:08	28.798735	-88.555997	1024.	T-7
114	N4X01021	24-NOV-1998	06:38:43	28.741682	-88.758097	989.	T-7
116	N4L01S06	24-NOV-1998	08:59:50	28.701058	-88.911348	922.	T-7
117	N4L01S06	24-NOV-1998	09:12:56	28.730493	-88.923862	775.	T-7
118	N4L01S05	24-NOV-1998	09:28:50	28.766982	-88.935768	628.	T-7
119	N4L01S04	24-NOV-1998	10:31:12	28.808113	-88.946460	491.	T-7
120	N4L01S03	24-NOV-1998	11:57:51	28.923172	-88.986128	146.	T-10
121	N4L01S02	24-NOV-1998	12:55:53	28.985717	-89.006293	73.	T-10
122	N4L01S02	24-NOV-1998	13:10:21	29.015960	-89.016973	55.	T-10
123	N4L01S01	24-NOV-1998	13:20:59	29.039025	-89.024137	39.	T-10

Launches missing sequence numbers were failures, except number 31 was determined bad during QA/QC, and numbers 70 and 90, where there was no launch but the counter advanced.

3.1.3 Cruise N5

The fifth NEGOM-COH hydrography cruise (N5) was conducted aboard the *R/V Gyre* 15-28 May 1999. It was staged out of Galveston, TX. Dr. Douglas C. Biggs and Dr. Norman L. Guinasso, Jr., were co-chief scientists. One hundred three CTD stations, including the test station, were completed and 118 XBT drops were made. CTD and XBT locations and cruise track are shown in Figure 3.1.3. Only the locations of the 96 successful XBT drops are shown. A first test station in Mississippi Canyon failed due to an electrical short. A successful test station (000, N5TEST01) was taken approximately at the seawardmost CTD station on line 1 and used the back-up CTD system. From this point, the cruise track ran along the 1000-m isobath to the seawardmost CTD station on line 4; XBTs were deployed and ADCP data were recorded during this transit. The first CTD station was taken at the seaward end of line 4, but the CTD package failed at about the 140-m depth. Due to failure of both the main and back-up CTD systems, XBTs were deployed at CTD and XBT stations as the cruise diverted up line 4 toward Pensacola, FL. Systems were repaired and CTD station 002 was taken at N5L04S05. The cruise then proceeded south, taking the CTD stations on the south half of the line. At the seaward end of line 4, the cruise track again ran along the 1000-m isobath to the seawardmost station on line 11. XBTs were dropped during this transit. CTD stations began again with the seawardmost station of line 11. On the return to line 4, CTDs were taken from the innermost station through and including a repeat of N5L04S05 (station number 082). The track then transited to the seawardmost station on line 3 and the normal sampling pattern resumed. The station number, date, time, location, water depth, and number of bottles tripped at each CTD station are shown in Table 3.1.7.

Stations at which bottle samples were taken are summarized in Table 3.1.8. Nutrients and oxygen were measured from every Niskin bottle depth sampled. Salinity was measured at all bottles at the most shoreward and most offshore stations, the test station, and at stations with bottle tripping problems, including double bottle trips, for at total of 48 stations. Pigment measurements were collected at the top bottle, the chlorophyll-maximum as determined by the downcast fluorescence trace, and the low light regime immediately below the chlorophyll-maximum at 61 stations. PM, POC, and PON were measured from the top and bottom bottles and, for PM, from a middle, "clear water" bottle at 61 stations. Surface bucket salinity samples were taken at 33 CTD/XBT stations over the inner shelf to better define the freshwater gradients that might be associated with springtime river discharge. These locations are noted in Table 3.1.7 with an asterisk.

The location, date, time, total water depth, and probe type of the 96 successful XBT drops are listed in Table 3.1.9. Both the ADCP and thermosalinograph ran continuously along the track from west of the test station to west of the innermost station on line 1 at cruise end. Flow-through, near-surface temperature, conductivity, and fluorescence were logged every 2 minutes. Surface samples were filtered and analyzed for chlorophyll *a* content to calibrate the flow-through fluorescence at 102 locations.

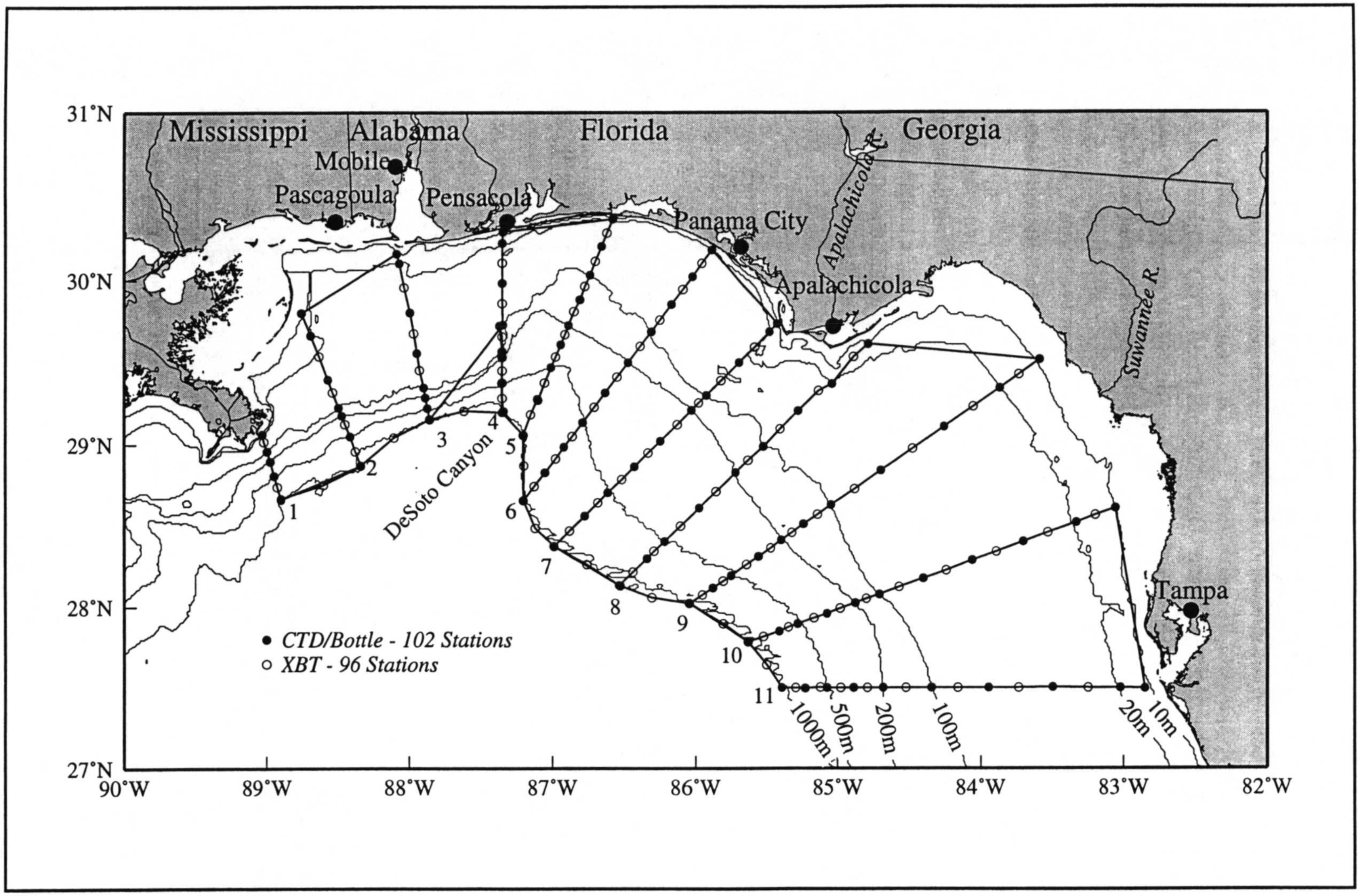


Figure 3.1.3. Station locations for cruise N5 conducted 15 - 28 May 1999. CTD stations began with the most seaward station on line 4. The thick line shows the cruise track, which began at the location of the most seaward station on line 1.

Four complementary research efforts, summarized below, were accommodated on cruise N5. Further information on these programs can be obtained from the scientists involved.

1) Net tows were made near local noon at 3 locations and at local midnight at 3 locations to collect zooplankton for Rebecca Scott, graduate student of Dr. Biggs, for her thesis research on correlation of standing stocks of zooplankton and micronekton with volume backscatter from upward-looking, moored ADCPs. As on previous cruises N2, N3, and N4, a one-meter net of 333-μm mesh was towed obliquely from surface to 100 m and back again to the surface.

2) A marine mammal distribution and abundance survey was conducted using bigeye binoculars by graduate students Joel Ortega-Ortiz, Trent Apple, and Glenn Gailey, assisted by Maureen Whittaker, an intern/volunteer with the TAMU-Galveston MMRP. This survey continued similar bigeye survey work done on previous cruises N1 through N4. Mr. Ortega-Ortiz will use this second springtime cruise of data in his dissertation. During N5, the four observers searched 1409 km of transect during 84 hours of effort and made 100 sightings, including sperm whales (7 individuals), Bryde's whale (the first sighting ever from *R/V Gyre*), and pygmy sperm and dwarf sperm whales.

3) Bisman Nababan and David Palandro, graduate students of Dr. Frank Muller- Karger of the USF Remote Sensing Laboratory, made bio-optical measurements of downwelling and sea-leaving radiance. When sunny days permitted, they used a multichannel Marine Environmental Radiometer twice daily at about 1000-1100 and 1400-1600 local time. The main objective was to continue and extend bio-optical data collection to calibrate a SeaWiFS satellite receiver and produce an algorithm for chlorophyll concentration estimates in the Gulf of Mexico using SeaWiFS satellite imagery. They also continued and extended the along-track measurement of dissolved organic matter fluorescence that USF had begun on previous cruises N3 and N4, and they sampled for dissolved organic matter from several depths at some of the CTD stations.

4) Elise Waltman, undergraduate student at TAMU, lead the effort to collect flow cytometry samples for post-cruise study by Dr. Lisa Campbell, TAMU Oceanography. Dr. Campbell will characterize the vertical distributions of bacteria and picophytoplankton in the northeastern Gulf.

Table 3.1.7. Times and positions for CTD stations on cruise N5.

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
000	N5TEST01	16-MAY-1999	18:43:01	28.666397	-88.899783	990.0	12
001	N5L04S12	17-MAY-1999	06:20:00	29.194797	-87.349723	1000.0	0
002	N5L04S05	17-MAY-1999	13:24:49	29.720580	-87.369063	70.0	12*
003	N5L04S07	17-MAY-1999	14:53:51	29.568103	-87.352330	104.0	12*
004	N5L04S08	17-MAY-1999	16:03:52	29.531955	-87.352423	192.0	8
005	N5L04S10	17-MAY-1999	18:06:12	29.371755	-87.354657	496.0	12
006	N5L04S12	17-MAY-1999	20:33:26	29.194047	-87.351255	1006.0	0
007	N5L04S12R	17-MAY-1999	21:45:29	29.194048	-87.351902	1006.0	12
008	N5L11S18	18-MAY-1999	15:56:00	27.498903	-85.394330	1010.0	12
009	N5L11S16	18-MAY-1999	18:20:23	27.498122	-85.224645	759.0	12
010	N5L11S14	18-MAY-1999	20:25:11	27.500277	-85.074872	496.0	12
011	N5L11S12	18-MAY-1999	22:08:06	27.500343	-84.888242	296.0	12
012	N5L11S10	18-MAY-1999	23:47:28	27.501000	-84.680917	199.0	12
013	N5L11S08	19-MAY-1999	02:11:34	27.499068	-84.342917	99.0	12
014	N5L11S06	19-MAY-1999	04:43:12	27.499638	-83.943517	57.0	7
015	N5L11S04	19-MAY-1999	07:43:35	27.501610	-83.497692	42.0	5
016	N5L11S02	19-MAY-1999	10:49:21	27.499157	-83.022852	21.0	4
017	N5L11S01	19-MAY-1999	12:04:01	27.498170	-82.852835	11.0	4
018	N5L10S01	19-MAY-1999	20:04:17	28.606642	-83.056983	11.0	4
019	N5L10S03	19-MAY-1999	22:02:07	28.519330	-83.331008	19.0	6
020	N5L10S05	20-MAY-1999	00:28:15	28.399972	-83.701697	30.0	5
021	N5L10S07	20-MAY-1999	02:53:32	28.285450	-84.059290	38.0	6
022	N5L10S09	20-MAY-1999	05:18:03	28.175087	-84.401635	59.0	6
023	N5L10S11	20-MAY-1999	07:35:18	28.076047	-84.708888	104.0	12
024	N5L10S13	20-MAY-1999	09:02:46	28.022160	-84.877715	200.0	12
025	N5L10S15	20-MAY-1999	10:46:14	27.959202	-85.072582	313.0	12
026	N5L10S17	20-MAY-1999	12:33:27	27.894930	-85.276928	494.0	12
027	N5L10S19	20-MAY-1999	14:14:34	27.848422	-85.410365	654.0	11
028	N5L10S21	20-MAY-1999	16:41:19	27.782290	-85.628507	981.0	12
029	N5L09S21	20-MAY-1999	21:12:03	28.019585	-86.043080	975.0	12
030	N5L09S19	20-MAY-1999	23:22:22	28.117013	-85.879123	675.0	12
031	N5L09S17	21-MAY-1999	01:00:31	28.190275	-85.753612	502.0	12
032	N5L09S15	21-MAY-1999	03:05:45	28.308977	-85.560913	304.0	12
033	N5L09S13	21-MAY-1999	04:45:04	28.411577	-85.396290	199.0	12
034	N5L09S11	21-MAY-1999	06:20:05	28.507863	-85.236182	162.0	12
035	N5L09S09	21-MAY-1999	08:26:28	28.626692	-85.044860	97.0	12
036	N5L09S07	21-MAY-1999	11:20:18	28.839577	-84.694638	45.0	6*
037	N5L09S05	21-MAY-1999	14:46:23	29.105920	-84.256193	26.0	6*
038	N5L09S03	21-MAY-1999	18:00:21	29.342285	-83.861790	18.0	4*
039	N5L09S01	21-MAY-1999	20:21:01	29.517190	-83.583545	9.0	4*
040	N5L08S01	22-MAY-1999	03:23:26	29.611940	-84.783363	10.0	3*
041	N5L08S03	22-MAY-1999	05:54:40	29.369840	-85.036547	26.0	4*
042	N5L08S05	22-MAY-1999	08:01:31	29.203835	-85.274507	41.0	8*
043	N5L08S07	22-MAY-1999	10:17:48	28.984423	-85.527525	132.0	12
044	N5L08S09	22-MAY-1999	12:10:49	28.824273	-85.717948	197.0	12
045	N5L08S11	22-MAY-1999	15:16:48	28.605673	-85.975782	308.0	12

Table 3.1.7. Times and positions for CTD stations on cruise N5 (continued).

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
046	N5L08S13	22-MAY-1999	17:50:05	28.401888	-86.216608	498.0	12
047	N5L08S15	22-MAY-1999	19:45:18	28.296818	-86.337912	672.0	12
048	N5L08S17	22-MAY-1999	22:05:39	28.132987	-86.533230	997.0	12
049	N5L07S17	23-MAY-1999	01:55:38	28.371348	-86.988037	1005.0	12
050	N5L07S15	23-MAY-1999	04:35:29	28.558022	-86.773817	666.0	12
051	N5L07S13	23-MAY-1999	06:41:02	28.700983	-86.612193	498.0	12
052	N5L07S11	23-MAY-1999	08:56:32	28.862460	-86.424810	381.0	12
053	N5L07S09	23-MAY-1999	10:59:51	29.016905	-86.245912	315.0	12
054	N5L07S07	23-MAY-1999	13:16:04	29.207792	-86.028670	200.0	12
055	N5L07S05	23-MAY-1999	14:38:52	29.298867	-85.921888	94.0	12
056	N5L07S03	23-MAY-1999	17:03:58	29.500120	-85.693242	30.0	5*
057	N5L07S01	23-MAY-1999	19:09:35	29.687695	-85.480335	20.0	4*
058	N5L07S00	23-MAY-1999	20:03:05	29.736615	-85.424360	10.0	3*
059	N5L06S01	24-MAY-1999	00:17:58	30.179210	-85.884550	20.0	4*
060	N5L06S03	24-MAY-1999	01:54:43	30.018400	-86.022882	31.0	4*
061	N5L06S05	24-MAY-1999	03:35:49	29.852383	-86.165463	46.0	4*
062	N5L06S07	24-MAY-1999	05:24:49	29.686750	-86.306370	97.0	12
063	N5L06S09	24-MAY-1999	08:16:08	29.499780	-86.471173	202.0	12
064	N5L06S11	24-MAY-1999	10:23:05	29.314053	-86.629422	380.0	12
065	N5L06S13	24-MAY-1999	12:29:50	29.132555	-86.787305	498.0	12
066	N5L06S15	24-MAY-1999	14:25:25	28.981422	-86.918503	615.0	12
067	N5L06S17	24-MAY-1999	16:27:16	28.826552	-87.052647	767.0	12
068	N5L06S19	24-MAY-1999	18:49:16	28.652740	-87.202405	994.0	12
069	N5L05S17	24-MAY-1999	22:33:41	29.054807	-87.206902	1001.0	12
070	N5L05S15	25-MAY-1999	01:15:57	29.273477	-87.104998	710.0	0
071	N5L05S15R	25-MAY-1999	01:37:57	29.268447	-87.101625	710.0	11
072	N5L05S13	25-MAY-1999	03:37:26	29.468453	-87.010285	489.0	12
073	N5L05S11	25-MAY-1999	05:26:05	29.608445	-86.939208	261.0	12
074	N5L05S09	25-MAY-1999	06:47:25	29.723748	-86.884882	198.0	12
075	N5L05S07	25-MAY-1999	08:28:52	29.880072	-86.809135	147.0	12
076	N5L05S05	25-MAY-1999	10:08:18	30.027400	-86.735810	98.0	12
077	N5L05S03	25-MAY-1999	11:45:57	30.202378	-86.655312	36.0	5*
078	N5L05S01	25-MAY-1999	13:10:56	30.367033	-86.578658	16.0	4*
079	N5L04S00	25-MAY-1999	18:20:52	30.290792	-87.348292	8.0	3*
080	N5L04S01	25-MAY-1999	19:10:10	30.221707	-87.351263	18.0	4*
081	N5L04S03	25-MAY-1999	21:05:52	29.979695	-87.350470	28.0	5**
082	N5L04S05R	25-MAY-1999	22:56:54	29.728768	-87.349355	79.0	8
083	N5L03S10	26-MAY-1999	04:23:55	29.151557	-87.860423	1019.0	12
084	N5L03S09	26-MAY-1999	05:59:08	29.219167	-87.874867	455.0	12*
085	N5L03S08	26-MAY-1999	07:06:38	29.283477	-87.888047	200.0	12*
086	N5L03S07	26-MAY-1999	08:05:54	29.347317	-87.901742	94.0	12
087	N5L03S05	26-MAY-1999	09:57:27	29.556323	-87.947060	40.0	6*
088	N5L03S03	26-MAY-1999	11:55:43	29.801343	-87.996628	37.0	5*
089	N5L03S01	26-MAY-1999	14:20:14	30.099568	-88.071337	20.0	4*
090	N5L03S00	26-MAY-1999	15:03:22	30.156123	-88.090488	12.0	4*
091	N5L02S00	26-MAY-1999	20:12:53	29.799803	-88.753942	14.0	4*

Table 3.1.7. Times and positions for CTD stations on cruise N5 (continued).

Station Number	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Depth (m)	No. of Bottles
092	N5L02S01	26-MAY-1999	21:25:48	29.664712	-88.694368	18.0	6*
093	N5L02S03	26-MAY-1999	23:33:45	29.394088	-88.570398	58.0	6
094	N5L02S05	27-MAY-1999	00:57:19	29.223547	-88.496293	113.0	12
095	N5L02S06	27-MAY-1999	02:04:37	29.173192	-88.472357	191.0	12
096	N5L02S08	27-MAY-1999	03:18:49	29.046382	-88.415820	506.0	12
097	N5L02S10	27-MAY-1999	05:12:54	28.867828	-88.337708	996.0	12
098	N5L01S07	27-MAY-1999	09:46:46	28.660740	-88.898337	1014.0	12*
099	N5L01S05	27-MAY-1999	12:01:30	28.804893	-88.947510	501.0	12*
100	N5L01S04	27-MAY-1999	13:22:56	28.895500	-88.974608	205.0	12*
101	N5L01S03	27-MAY-1999	14:36:58	28.956793	-88.995408	101.0	12
102	N5L01S01	27-MAY-1999	15:44:04	29.059717	-89.030182	17.0	5*

* Additionally a surface bucket salinity sample was drawn here.

** A surface bucket salinity sample was drawn here and also at a light meter cast just before this station.

Table 3.1.8 Number of bottles sampled by variable on cruise N5.

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
000	N5TEST01	12	12	12	0	0	0
001	N5L04S12	0	0	0	0	0	0
002	N5L04S05	12	12	12	3	3	2
003	N5L04S07	12	12	0	3	3	2
004	N5L04S08	8	8	8	3	1	1
005	N5L04S10	12	12	2	3	3	2
006	N5L04S12	0	0	0	0	0	0
007	N5L04S12R	12	12	12	3	2	1
008	N5L11S18	12	12	12	5	3	2
009	N5L11S16	12	12	2	0	0	0
010	N5L11S14	12	12	2	3	3	2
011	N5L11S12	12	12	2	0	0	0
012	N5L11S10	12	12	3	3	3	2
013	N5L11S08	12	12	2	3	3	2
014	N5L11S06	7	7	0	0	0	0
015	N5L11S04	5	5	0	3	3	2
016	N5L11S02	4	4	0	2	2	2
017	N5L11S01	4	4	4	0	0	0
018	N5L10S01	4	4	4	0	0	0
019	N5L10S03	6	6	0	2	3	2
020	N5L10S05	5	5	0	2	3	2
021	N5L10S07	6	6	0	2	3	2
022	N5L10S09	6	6	0	0	0	0
023	N5L10S11	12	12	12	3	3	2

Table 3.1.8 Number of bottles sampled by variable on cruise N5 (continued).

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
024	N5L10S13	12	12	12	3	3	2
025	N5L10S15	12	12	12	0	0	0
026	N5L10S17	12	12	0	4	3	2
027	N5L10S19	11	11	0	0	0	0
028	N5L10S21	12	12	12	3	3	2
029	N5L09S21	12	12	12	3	3	2
030	N5L09S19	12	12	0	0	0	0
031	N5L09S17	12	12	0	3	3	2
032	N5L09S15	12	12	0	0	0	0
033	N5L09S13	12	12	12	3	3	2
034	N5L09S11	12	12	0	0	0	0
035	N5L09S09	12	12	0	4	3	2
036	N5L09S07	6	6	0	3	3	2
037	N5L09S05	6	6	0	2	3	2
038	N5L09S03	4	4	0	2	3	2
039	N5L09S01	4	4	4	0	0	0
040	N5L08S01	3	3	3	0	0	0
041	N5L08S03	4	4	0	2	3	2
042	N5L08S05	8	8	8	0	0	0
043	N5L08S07	12	12	12	4	3	2
044	N5L08S09	12	12	0	3	3	2
045	N5L08S11	12	12	12	0	0	0
046	N5L08S13	12	12	2	3	3	2
047	N5L08S15	12	12	2	0	0	0
048	N5L08S17	12	12	12	3	3	2
049	N5L07S17	12	12	12	3	3	2
050	N5L07S15	12	12	0	0	0	0
051	N5L07S13	12	12	0	4	3	2
052	N5L07S11	12	12	0	0	0	0
053	N5L07S09	12	12	12	0	0	0
054	N5L07S07	12	12	0	4	3	2
055	N5L07S05	12	12	0	3	3	2
056	N5L07S03	5	5	2	0	0	0
057	N5L07S01	4	4	0	2	3	2
058	N5L07S00	3	3	3	0	0	0
059	N5L06S01	4	4	4	2	3	2
060	N5L06S03	4	4	0	0	0	0
061	N5L06S05	4	4	0	0	0	0
062	N5L06S07	12	12	12	4	3	2
063	N5L06S09	12	12	0	3	3	2
064	N5L06S11	12	12	0	0	0	0
065	N5L06S13	12	12	12	4	3	2
066	N5L06S15	12	12	0	0	0	0
067	N5L06S17	12	12	0	0	0	0
068	N5L06S19	12	12	12	3	3	2
069	N5L05S17	12	12	12	3	3	2

Table 3.1.8 Number of bottles sampled by variable on cruise N5 (continued).

Station Number	Station Name	Nutrients	Oxygen	Salinity	Pigments	PM*	POC & PON*
070	N5L05S15	0	0	0	0	0	0
071	N5L05S15R	11	11	11	0	0	0
072	N5L05S13	12	12	0	3	3	2
073	N5L05S11	12	12	0	0	0	0
074	N5L05S09	12	12	5	5	3	2
075	N5L05S07	12	12	12	0	0	0
076	N5L05S05	12	12	0	3	3	2
077	N5L05S03	5	5	0	0	0	0
078	N5L05S01	4	4	0	2	3	2
079	N5L04S00	3	3	3	0	0	0
080	N5L04S01	4	4	0	2	3	2
081	N5L04S03	5	5	2	0	0	0
082	N5L04S05R	8	8	0	0	0	0
083	N5L03S10	12	12	12	3	3	2
084	N5L03S09	12	12	0	3	3	2
085	N5L03S08	12	12	0	3	3	2
086	N5L03S07	12	12	0	4	3	2
087	N5L03S05	6	6	0	0	0	0
088	N5L03S03	5	5	0	0	0	0
089	N5L03S01	4	4	0	2	3	2
090	N5L03S00	4	4	4	0	0	0
091	N5L02S00	4	4	4	0	0	0
092	N5L02S01	6	6	0	3	3	2
093	N5L02S03	6	6	0	0	0	0
094	N5L02S05	12	12	0	2	3	2
095	N5L02S06	12	12	0	2	3	2
096	N5L02S08	12	12	0	3	3	2
097	N5L02S10	12	12	12	4	3	2
098	N5L01S07	12	12	12	4	3	2
099	N5L01S05	12	12	0	3	3	2
100	N5L01S04	12	12	0	3	3	2
101	N5L01S03	12	12	3	3	3	2
102	N5L01S01	5	5	5	3	3	2

* POC = particulate organic carbon; PON = particulate organic nitrogen; PM = total particulate material; R = Repeat of station cast

Table 3.1.9 Launch times and locations for XBT drops on cruise N5.

Sequence Number*	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
001	N5X0102M	16-MAY-1999	21:58:12	28.749868	-88.599668	990.0	T7
002	N5L02S10	16-MAY-1999	23:46:51	28.869473	-88.337737	996.0	T7
003	N5X0203M	17-MAY-1999	01:34:17	29.039445	-88.109035	1000.0	T7
004	N5L03S10	17-MAY-1999	03:16:22	29.151522	-87.860842	1019.0	T7
007	N5X0304M	17-MAY-1999	04:41:43	29.202892	-87.619437	980.0	T7
008	N5L04S12	17-MAY-1999	07:35:10	29.199160	-87.344155	1006.0	T7
009	N5L04S11	17-MAY-1999	08:24:32	29.282365	-87.350738	838.0	T7
011	N5L04S10	17-MAY-1999	09:14:18	29.375908	-87.350723	481.0	T7
012	N5L04S09	17-MAY-1999	09:53:00	29.450082	-87.351700	356.0	T7
013	N5L04S08	17-MAY-1999	10:35:06	29.532043	-87.351208	178.0	T10
014	N5L04S07	17-MAY-1999	10:54:23	29.568020	-87.350762	107.0	T10
015	N5L04S06	17-MAY-1999	11:40:45	29.657083	-87.350683	80.0	T10
016	N5L05S17	17-MAY-1999	23:56:18	29.054750	-87.205100	493.0	T7
017	N5X0506M	18-MAY-1999	01:11:49	28.869243	-87.199128	998.0	T7
018	N5L06S19	18-MAY-1999	02:38:28	28.653043	-87.202357	994.0	T7
020	N5X0607M	18-MAY-1999	03:50:32	28.482500	-87.118520	967.0	T7
021	N5L07S17	18-MAY-1999	04:52:43	28.370910	-86.988190	1035.0	T7
022	N5X0708M	18-MAY-1999	06:42:50	28.261122	-86.759127	1123.0	T7
024	N5L08S17	18-MAY-1999	08:20:02	28.129373	-86.526427	1230.0	T7
025	N5X0809M	18-MAY-1999	09:39:14	28.057558	-86.303443	1006.0	T7
026	N5L09S21	18-MAY-1999	11:05:14	28.018955	-86.042813	975.0	T7
028	N5X0910M	18-MAY-1999	12:29:48	27.895843	-85.809000	992.0	T7
029	N5L10S21	18-MAY-1999	13:38:34	27.783690	-85.630532	981.0	T7
031	N5X1011M	18-MAY-1999	14:43:38	27.641718	-85.502062	1156.0	T7
032	N5L11S17	18-MAY-1999	17:47:37	27.500140	-85.294072	835.0	T7
035	N5L11S15	18-MAY-1999	20:02:10	27.503528	-85.123215	633.0	T7
036	N5L11S13	18-MAY-1999	21:33:03	27.500512	-84.977695	390.0	T7
037	N5L11S11	18-MAY-1999	23:05:28	27.500395	-84.791913	235.0	T7
038	N5L11S09	19-MAY-1999	01:03:43	27.500220	-84.523787	138.0	T10
039	N5L11S07	19-MAY-1999	03:29:02	27.500093	-84.159768	70.0	T10
040	N5L11S05	19-MAY-1999	06:10:30	27.500850	-83.732597	49.0	T10
041	N5L11S03	19-MAY-1999	09:21:40	27.499918	-83.149893	33.0	T10
042	N5L10S02	19-MAY-1999	21:06:27	28.563855	-83.195073	17.0	T10
043	N5L10S04	19-MAY-1999	23:22:14	28.456048	-83.528295	26.0	T10
044	N5L10S06	20-MAY-1999	01:44:21	28.340145	-83.887077	28.0	T10
045	N5L10S08	20-MAY-1999	04:08:13	28.223740	-84.239738	49.0	T10
046	N5L10S10	20-MAY-1999	06:35:27	28.122425	-84.569272	74.0	T10
047	N5L10S12	20-MAY-1999	08:28:12	28.048683	-84.799102	150.0	T10
049	N5L10S14	20-MAY-1999	10:06:22	27.990628	-84.981053	250.0	T7
050	N5L10S16	20-MAY-1999	11:46:12	27.930612	-85.167028	391.0	T7
053	N5L10S18	20-MAY-1999	13:33:26	27.874315	-85.344273	594.0	T7
055	N5L10S20	20-MAY-1999	15:50:57	27.817552	-85.525715	751.0	T7
056	N5L09S20	20-MAY-1999	22:48:12	28.072080	-85.950800	804.0	T7
059	N5L09S18	21-MAY-1999	00:32:37	28.158722	-85.806980	588.0	T7
063	N5L09S16	21-MAY-1999	02:27:14	28.261105	-85.638998	359.0	T7

Table 3.1.9 Launch times and locations for XBT drops on cruise N5 (continued).

Sequence Number*	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
065	N5L09S14	21-MAY-1999	04:07:04	28.362018	-85.475690	240.0	T7
066	N5L09S12	21-MAY-1999	05:39:53	28.457683	-85.318842	179.0	T10
067	N5L09S10	21-MAY-1999	07:30:28	28.567287	-85.138983	129.0	T10
068	N5L09S08	21-MAY-1999	09:54:32	28.723962	-84.881827	51.0	T10
069	N5L09S06	21-MAY-1999	13:04:07	28.971828	-84.475917	35.0	T10
070	N5L09S04	21-MAY-1999	16:20:07	29.230437	-84.051945	25.0	T10
071	N5L09S02	21-MAY-1999	19:10:24	29.427340	-83.728713	16.0	T10
072	N5L08S02	22-MAY-1999	04:18:16	29.533313	-84.887210	14.0	T10
074	N5L08S04	22-MAY-1999	06:40:25	29.325828	-85.132370	27.0	T10
075	N5L08S06	22-MAY-1999	09:15:11	29.094267	-85.403170	50.0	T10
077	N5L08S08	22-MAY-1999	11:23:07	28.902332	-85.627807	171.0	T10
078	N5L08S10	22-MAY-1999	13:40:00	28.709927	-85.854018	261.0	T7
079	N5L08S12	22-MAY-1999	16:54:04	28.496633	-86.104488	379.0	T7
080	N5L08S14	22-MAY-1999	19:14:04	28.341605	-86.287378	581.0	T7
081	N5L08S16	22-MAY-1999	21:16:43	28.213132	-86.438453	819.0	T7
083	N5L07S16	23-MAY-1999	03:43:10	28.466572	-86.878578	778.0	T7
085	N5L07S14	23-MAY-1999	06:02:46	28.638803	-86.680362	579.0	T7
086	N5L07S12	23-MAY-1999	08:05:07	28.784448	-86.513962	424.0	T7
087	N5L07S10	23-MAY-1999	10:13:00	28.944987	-86.329962	344.0	T7
088	N5L07S08	23-MAY-1999	12:23:06	29.119720	-86.127405	257.0	T7
089	N5L07S06	23-MAY-1999	14:04:53	29.251542	-85.978907	158.0	T10
090	N5L07S04	23-MAY-1999	15:57:19	29.387597	-85.822815	51.0	T10
091	N5L07S02	23-MAY-1999	18:15:31	29.593750	-85.586787	28.0	T10
092	N5L06S02	24-MAY-1999	01:07:51	30.098877	-85.954773	30.0	T10
093	N5L06S04	24-MAY-1999	02:44:16	29.942408	-86.090025	40.0	T10
094	N5L06S06	24-MAY-1999	04:38:19	29.759083	-86.248243	68.0	T10
095	N5L06S08	24-MAY-1999	06:27:17	29.600320	-86.384948	129.0	T10
096	N5L06S10	24-MAY-1999	09:26:10	29.410417	-86.548977	285.0	T10
097	N5L06S12	24-MAY-1999	11:37:00	29.225933	-86.708037	433.0	T7
098	N5L06S14	24-MAY-1999	13:45:18	29.048705	-86.860882	502.0	T7
099	N5L06S16	24-MAY-1999	15:38:02	28.911840	-86.979082	664.0	T7
100	N5L06S18	24-MAY-1999	17:58:29	28.742610	-87.124932	838.0	T7
101	N5L05S16	25-MAY-1999	00:29:48	29.181297	-87.150042	825.0	T7
102	N5L05S14	25-MAY-1999	02:52:34	29.374718	-87.055578	623.0	T7
103	N5L05S12	25-MAY-1999	04:41:09	29.533930	-86.979005	342.0	T7
104	N5L05S10	25-MAY-1999	06:17:08	29.671210	-86.912920	220.0	T10
105	N5L05S08	25-MAY-1999	07:47:41	29.808157	-86.847023	169.0	T10
106	N5L05S06	25-MAY-1999	09:25:10	29.959593	-86.773817	124.0	T10
107	N5L05S04	25-MAY-1999	11:01:05	30.111158	-86.700718	95.0	T10
108	N5L05S02	25-MAY-1999	12:31:21	30.283422	-86.617528	28.0	T10
109	N5L04S02	25-MAY-1999	20:05:28	30.102883	-87.351005	30.0	T10
110	N5L04S04	25-MAY-1999	22:03:13	29.856622	-87.353187	44.0	T10
111	N5L03S06	26-MAY-1999	09:09:06	29.452913	-87.928075	62.0	T10
112	N5L03S04	26-MAY-1999	11:00:46	29.678142	-87.972053	41.0	T10
113	N5L03S02	26-MAY-1999	13:09:43	29.953213	-88.038470	33.0	T10

Table 3.1.9 Launch times and locations for XBT drops on cruise N5 (continued).

Sequence Number*	Station Name	Date (UTC)	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Probe Type
114	N5L02S02	26-MAY-1999	22:27:05	29.538692	-88.634897	29.0	T10
115	N5L02S04	27-MAY-1999	00:15:54	29.316062	-88.537555	65.0	T10
116	N5L02S07	27-MAY-1999	02:42:53	29.122967	-88.450927	289.0	T7
117	N5L02S09	27-MAY-1999	04:27:26	28.955068	-88.376638	881.0	T7
119	N5L01S06	27-MAY-1999	11:25:50	28.736552	-88.925840	754.0	T7
120	N5L01S02	27-MAY-1999	15:22:07	29.015678	-89.017038	55.0	T10

* Launches of 21 T7s and 1 T10 failed due to bad probes; missing sequence numbers 006 and 076 were cases where there was no launch but the counter advanced.

3.2 Instrumentation, Calibration, and Sampling Procedures

Standard oceanographic instrumentation and sampling procedures were used to collect measurements on the NEGOM-COH cruises. Data taken at each station consist of five types—continuous profiles, discrete measurements, ADCP measurements, XBT profiles, and supplementary underway measurements. The equipment and data collection procedures for each were summarized in the first NEGOM-COH report (Jochens and Nowlin, 1998). Below are given changes in methods or procedures and additional information on data collection. Processing of data from cruises N3 and N4 was completed, but data processing for cruise N5 was in progress at the time of this report.

3.2.1 Continuous Profiles

Continuous profiles versus pressure were made of temperature, conductivity, downwelling irradiance (with a photosynthetically available radiation (PAR) sensor), transmissivity, fluorometry, optical backscatter, and, although not contractually required, dissolved oxygen. Instruments were mounted on the Rosette frame below the Niskin water bottles and Rosette system to provide unperturbed, obstruction-free flow of water to all instruments during the downcast. The various instruments were interfaced with the CTD, which transmitted data to the Sea-Bird SBE-11 deck unit for data logging and storage. The altimeter allowed the CTD package to be lowered to within 1-5 meters of the sea floor. The hydrographic equipment used on the cruises is given in Table 3.2.1. Sensor specifications and methods were detailed in Jochens and Nowlin (1998).

Two sets of instruments were taken on each cruise to provide back-up instrumentation. This redundancy helped assure collection of complete data sets for each parameter. No major CTD equipment failure occurred on cruises N3 and N4. Major equipment failure on N5 included problems with the CTD electrical systems and bottle tripping mechanical systems. These failures were repaired during the cruise. The major impact on data collection was the loss of the deep half (deeper than ~400 m) of the CTD cast at N5L05S15 (two casts: 70 and 71) and the loss of the near-surface water samples at 12 of the 18 stations at which double bottle trips or failure of the Rosette sampler occurred.

Table 3.2.1 Hydrographic equipment available on cruises N3, N4, and N5.

Instrument	Manufacturer	Quantity
CTD system	Sea-Bird SBE-911*plus*	2
CTD deck unit	Sea-Bird SBE-11	2
Rosette system	General Oceanics 12 place	2
Rosette frame	TAMU fabrication	2
Niskin bottles	GO Lever Action, 10 liter	14
Oxygen sensor	Sea-Bird SBE 13, Beckman polarographic	2
Niskin bottles	GO Standard, 10-12 liter	10
Transmissometer	25-cm SeaTech 2000 m	2
Fluorometer	Chelsea Instruments	2
Optical backscatter	SeaTech Light scattering sensor	2
PAR sensor	Biospherical QSP-200L	2
Altimeter	Datasonics PSA-900	2

3.2.2 Discrete Measurements

Water samples for discrete measurements were collected from 10-liter Niskin bottles mounted on a General Oceanics Rosette sampler. Typically, four to 12 bottles per station were used. Bottles were tripped at the maximum CTD depth, at the sea surface (~3 m), and in the chlorophyll maximum as determined from the fluorescence profile by the CTD operator. Other bottles were tripped at the specified sigma-theta surfaces, when present, given in Table 3.2.2. A number of these surfaces are associated with specific water masses in the Loop Current. The CTD operator had the discretion to trip unused bottles to fill gaps in bottle spacing or to sample in interesting features in the temperature, salinity, fluorescence, or percent transmission profiles. On cruise N5, extra bottles, when available, were taken at 20-m and 50-m depths for flow cytometry sampling. Generally, in water depths of 100 m or more, all 12 bottles were tripped regardless of availability of sigma-theta surfaces.

Discrete water samples were taken for nutrients (phosphate, silicate, nitrate, nitrite, ammonium, and urea) and dissolved oxygen at all stations and for PM, POC/PON, and phytoplankton pigments at approximately 60 stations. The PM/POC/PON and pigment samples were taken from the same stations to facilitate integration and interpretation of data. For salinity, samples were measured at bottles from the inshore-most and offshore-most stations, from leaking bottles, and for stations with unplanned bottle trips. See Tables 3.1.2, 3.1.5, and 3.1.8 for N3, N4, and N5, respectively, for details.

Table 3.2.2 Bottle tripping locations.

Trip Location	Comments
Top	generally about 3-m depth
Chlorophyll maximum	as indicated by downcast fluorescence maximum
Bottom	generally 1 to 5 m above sea floor
Available σ surfaces:	
24.6	
25.4	salinity maximum in Subtropical Underwater
25.9	
26.2	
26.5	oxygen maximum in 18°C Sargasso Sea Water
26.8	
27.0	
27.15 or 27.10	oxygen minimum in Tropical Atlantic Central Water
27.45	salinity minimum in Antarctic Intermediate Water
Other bottles if available	interesting features in downcast profiles or for spacing

Water samples were drawn and processed as soon as the CTD-Rosette system was brought on-board. Analyses of dissolved oxygen, nutrients, and salinity were performed at sea. Samples for PM, POC/PON, and phytoplankton pigments were filtered at sea, and the filters returned for final processing onshore. Methods and analysis specifications were provided in the first NEGOM-COH annual report (Jochens and Nowlin, 1998).

Particulate organic nitrogen (PON) measurements were made on all NEGOM-COH cruises. Although not required by the contract, PON data are included in the master bottle data sets for each cruise. Methods of sample collection and analysis for the POC/PON filters are described in Jochens and Nowlin (1998). PON and POC values were determined from the same filter sample with a CHN elemental analyzer. The analysis procedure is outlined in the U. S. JGOFS BATS Method Manual (Knap et al., 1997). POC/PON filter samples for N1 through N4 were analyzed at the Bermuda Station for Biological Research; filters from N5 were sent for analysis to the Virginia Institute of Marine Science.

3.2.3 Acoustic Doppler Current Profiler Measurements

ADCP measurements were made along track on cruises N3, N4, and N5. Data were collected using a 150-kHz broad-band ADCP (S/N 1183) for cruises N3 and N5 and a 150-kHz narrow-band ADCP (S/N 355) for cruise N4. The narrow-band ADCP used on N4 was the back-up to the broad-band ADCP, which had failed early in the cruise when the ship's hull grazed an uncharted sand bar created by Hurricane Georges, damaging the broad-band ADCP. The assistance of divers was required to remove the damaged ADCP from the instrument well. This occurred at an inshore location on line 4, after which the narrow-band ADCP was operational. Figure 3.2.1 shows the locations of the bins with good data, giving the general cruise tracks for collection of ADCP data. Dates of data collection and quantity of raw ADCP and navigation data are summarized in Table 3.2.3.

Both ADCPs were manufactured by RD Instruments, Inc. (RDI). Differential global positioning system (DGPS) fixes were used when available. ADCP data processing, recording, and instrument control used the RDI TRANSECT program. Details on instrument specifications, mounting on the vessel, data processing, and associated navigation data are provided in Jochens and Nowlin (1998).

An Ashtech ADU2 3DF positioning antenna array (S/N AD00251) was installed on the top deck of the *R/V Gyre* prior to cruise N3. It was used on cruises N3 through N5 to collect high-precision positioning information. The Ashtech data allowed the processing and quality control of ADCP data collected while on-station. They also allowed the elimination of bad ensembles (lasting 8 to 10 seconds) prior to calculating the 5-minute average segments (see Section 4.4).

The configurations recorded for the ADCP during each cruise are shown in Table 3.2.4. Configurations are basically identical for each cruise (except for the use of a narrow-band ADCP during N4) to enhance continuity among the different cruises and to simplify analysis and interpretation.

Table 3.2.3. Dates and quantity of ADCP data

Cruise	ADCP Start (UTC)	ADCP Stop (UTC)	Acquisition Program	Quantity of Data (Mbyte)
N3	25 Jul 1998 04:49	08 Aug 1998 16:10	TRANSECT	350
N4	22 Nov 1998 03:25	24 Nov 1998 23:56	TRANSECT	41
N5	15 May 1999 07:45	28 May 1999 02:29	TRANSECT	250

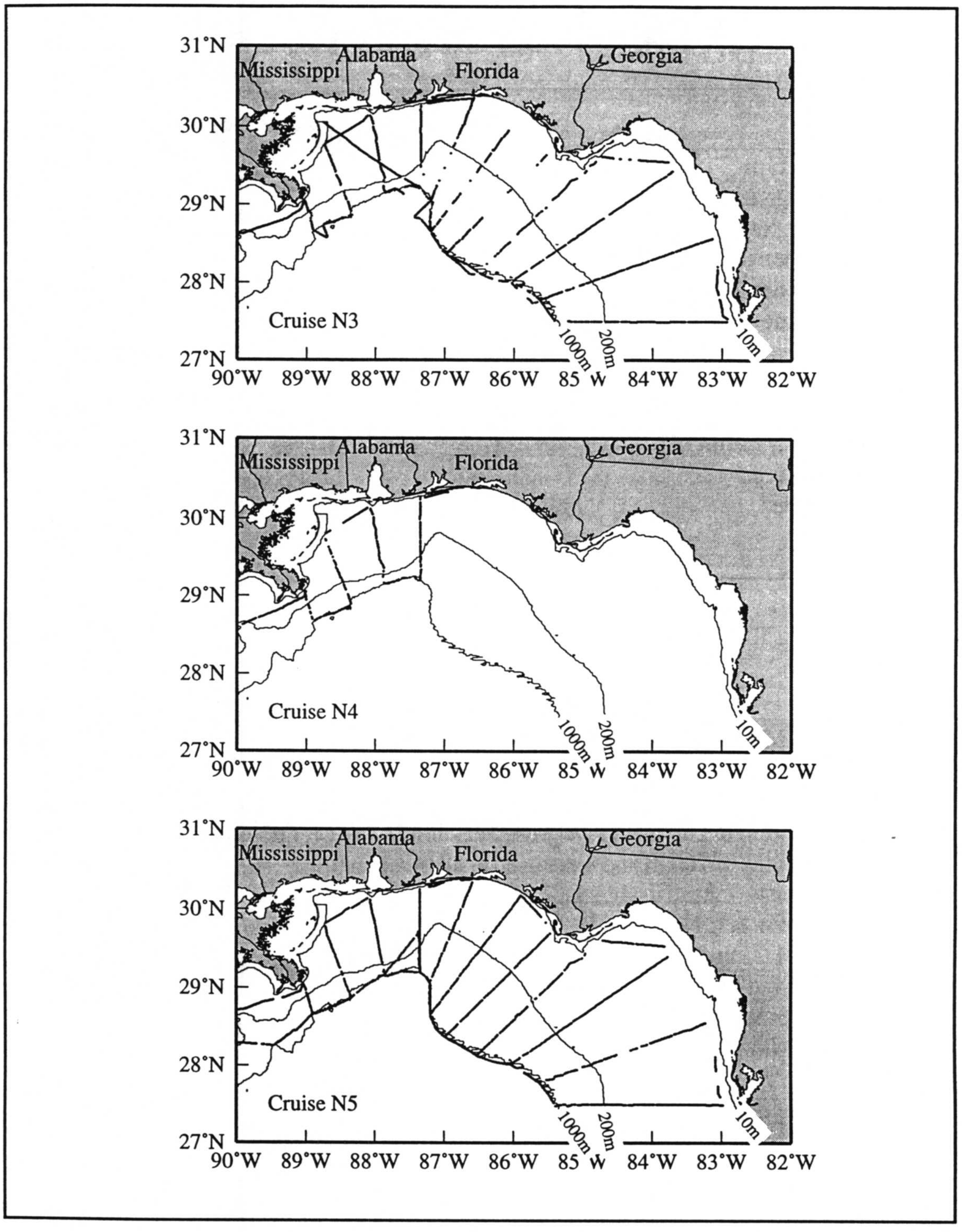


Figure 3.2.1. Locations of ensemble ADCP data for cruises N3, N4, and N5.

Table 3.2.4. ADCP configuration summary.

Parameter	Cruise		
	N3	**N4**	**N5**
Instrument type	broad-band	narrow-band	broad-band
Frequency (kHz)	153.6	153.6	153.6
Transducer pattern	convex	concave	convex
Depth cell length (m)	4	4	4
Number of depth cells	90	90	60
Segment time (minutes)	5	5	5
Time between pings (sec)	1	1	1
First bin depth (m)	14	14	14
Transmit pulse length (m)	4	4	4
Blank after transmit (m)	4	4	4
Navigation type	DGPS	DGPS	DGPS
Data recorded	raw, navigation, and averaged	raw, navigation, and averaged	raw, navigation, and averaged

3.2.4 XBT Measurements

Expendable bathythermograph (XBT) profiles were obtained using Sippican, Inc., T-7 and T-10 probes. T10s operate to 200 m and were used at stations in water depths of 200 m or shallower. T7s operate to depths of 760 m and were used at all other stations. The probe type for each XBT deployment which produced usable data, as well as the drop locations, are given in Tables 3.1.3, 3.1.6, and 3.1.9 for N3, N4, and N5, respectively. XBT deployment locations are shown in Figures 3.1.1, 3.1.2, and 3.1.3 for N3, N4, and N5, respectively. On N3, there were 101 successful XBTs out of 108 launches. On N4, there were 122 XBT launches with ten failures. On N5, 118 XBTs were released with 22 failures. Methods for deployment were detailed in Jochens and Nowlin (1998).

XBTs were deployed between CTD stations to increase the spatial resolution of the temperature field to 10-20 km. Except where CTD stations are close together, one XBT was deployed midway between cross-shelf CTD stations. To test whether significant variability exists at very small cross-shelf spatial scales, the number of XBTs deployed between CTD stations on lines 1 and 5 was doubled on N4. Subsequent analysis confirmed the original spacing was sufficient to resolve the principal energetic cross-shelf temperature scales (Section 2.2). XBTs also were dropped along the 1000-m isobath.

3.2.5 Underway Measurements

Near-surface (~3 m) temperature, conductivity, and fluorescence were logged every 2 minutes throughout cruises N3, N4, and N5 using the Serial ASCII Interface Loop (SAIL) system on the *R/V Gyre*. These measurements continued and extended similar data logging during cruises N1 and N2 in the first field year. Details on sensors, logging procedures, calibration procedures, and QA/QC of underway measurements were given in the first annual report (Jochens and Nowlin, 1998). During the second year, data were usually logged from port of departure to port of return. Raw data from each cruise generally are better than 99.9% complete for deadhead as well as along designated station lines. The only significant breaks in the SAIL data logging occurred on cruise N4. During the deadhead transit from Gulfport, MS, to DeSoto Canyon, navigation input problems twice locked up the data acquisition system and prevented portions of the SAIL data string from being logged; these hiatus periods were 2157 - 2304 UTC on 13 November 1998 and 1717 - 1757 UTC on 14 November 1998. During two other deadhead periods on cruises N4 and N5, flow to the temperature and conductivity sensors slowed or stopped and no data were collected; these hiatus periods were 0505 - 0853 UTC on 13 November 1998 and 2251 - 2317 UTC on 16 May 1999. Other down time during N3, N4, and N5 was approximately 2 to 4 minutes per day (loss of one or at most two scans) when the SAIL data computer was backed up. Locations of discrete samples that were filtered for calibration of the flow-through fluorometer data are given in Figure 3.2.2.

These underway measurements of near-surface temperature (SST), conductivity (SSS), and chlorophyll fluorescence (SSC) are supplemental to the contractually required data discussed in Sections 3.2.1 through 3.2.4. However, these underway data are useful in fixing the location of river plumes and other confluence and frontal regimes. And, in collaboration with Dr. Frank Muller-Karger's bio-optical group at USF, the TAMU and USF fluorometers, in tandem, measured sea surface chlorophyll and sea surface dissolved organic matter.

3.3 Summary of Field Data Collected

A summary of the data collected and scientific participation on the three cruises conducted in this reporting period is given in Table 3.3.1. Samples taken at the test stations are not included in this tabulation. In addition, visiting researchers on each cruise collected complementary data for use in their individual research programs. Information relative to these complementary programs is given in Table 3.3.2 and described in section 3.1.

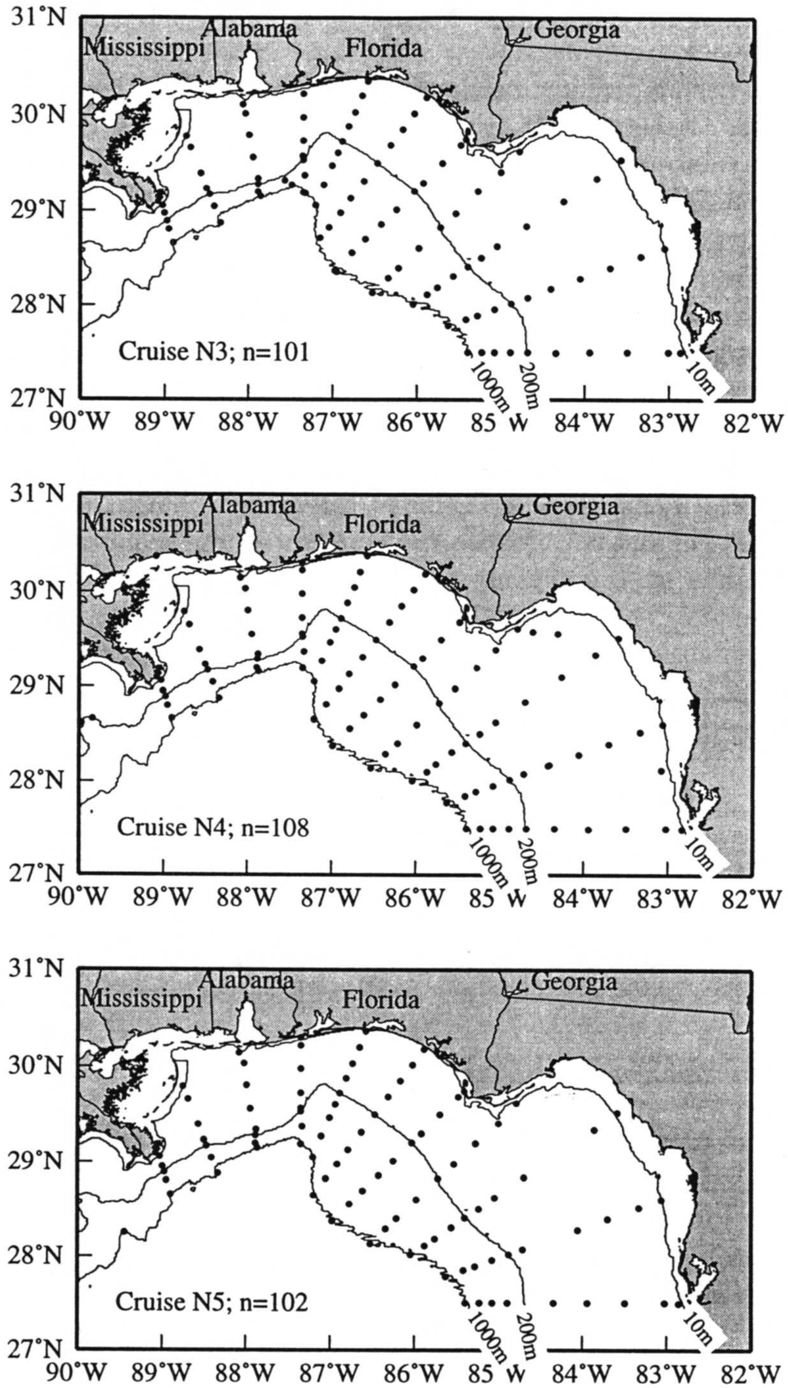


Figure 3.2.2. Locations of discrete samples filtered for calibration at sea of flow-through fluorometer data on cruises N3, N4, and N5.

Table 3.3.1. Summary of data collection and scientific participation on NEGOM-COH cruises. Cruise duration and track length represent port-to-port values; the cross-shelf track is approximately 2742 km. Numbers from test/supplemental stations are excluded.

Description	**N3 July/Aug 1998**	**N4 Nov 1998**	**N5 May 1999**
Cruise duration (days)	13	12	14
Cruise track (km)	3817*	3815*	4497**
Total hydrographic stations	100	99	103
CTD stations, excluding test stations	98	98	102
Nutrient stations	98	98	100
Oxygen stations	98	98	100
Salinity stations	22	22	48
Pigment stations	58	59	61
Particulate matter stations	60	60	61
Particulate organic carbon stations	60	60	61
Surface chlorophyll stations	101	108	102
XBT drops (successful/total)	101/108	112/122	96/118
Nutrient samples	883	901	925
Oxygen samples	883	900	925
Salinity samples	180	167	358
Surface bucket salinity samples	0	0	33
Pigment samples	169	163	183
Particulate matter samples	181	178	179
Particulate organic carbon samples	118	120	113
Surface chlorophyll samples	101	108	102
Underway surface temperature and conductivity logging	2 min	2 min	2 min
Underway surface fluorescence logging	2 min	2 min	2 min
Total scientific party	23	22	23
NEGOM-COH scientists	13	15	15
Guest investigators on board	10	6	8
Students (graduate and undergraduate)	12	9	10
Complementary studies	7	5	4

* Gulfport, MS, to Galveston, TX.

** Galveston, TX, to Galveston, TX.

Table 3.3.2 Complementary programs on NEGOM-COH hydrography surveys.

Description	**N3July/Aug 1998**	**N4November 1998**	**N5May1999**
Guest investigators on board or on shore	14	9	8
Drifter launches	30	24	0
XBTs for PALACE float deployments	4	0	0
Current meter mooring work stations	1	1	0
Marine mammal watchers	4	4	4
Sea bird census observers	2	0	0
Altimeter-*in situ* data trainees	1	0	0
Bio-optical stations	~2 / day	~2 / day	~2 / day
Plankton net tow stations	15	12	6
Flow cytometry samples	0	0	251

3.4 Summary of Historical and Concurrent Data Assembly

Concurrent data sets were identified and assembled, including sea surface height anomaly (SSHA) from satellite altimeter, sea surface temperature from satellite Advanced Very High Resolution Radiometer (AVHRR) sensors, and ocean color from the SeaWiFS satellite. Ancillary data were acquired, including river discharge, surface wind speed and direction, air temperature, surface barometric pressure, frontal passages, and sea level.

4 DATA QUALITY ASSURANCE AND CONTROL

Data processing and quality assurance/quality control (QA/QC) methods for each type of data were presented in the first annual report (Jochens and Nowlin, 1998). Changes to those methods and a summary of the results of QA/QC processing for July 1998 through June 1999 are given in this section. This section includes results from cruises N2, N3, and N4.

4.1 Continuous Profile Data

The composite plots of CTD temperature versus salinity for cruises N3 (summer 1998) and N4 (fall 1998) show good quality results for the continuous sensors (Figures 4.1.1 and 4.1.2, respectively). Note the seasonal differences for temperatures higher than 18°C and the lack of scatter and the tight fit below 18°C.

4.2 Discrete Measurements: Nutrients, Oxygen, and Salinity

Nitrate versus phosphate concentrations for cruises N2, N3, and N4 are shown in Figure 4.2.1. The Redfield ratio of 16:1 for N:P is indicated by the line. Note that nitrate values are high relative to this ratio. Several nutrient data points are still under investigation, but many of the unusual points are from areas directly influenced by river discharge.

The composite plot of bottle salinity versus CTD salinity for cruises N2 through N4 is shown in Figure 4.2.2. Overall agreement is good, as shown by the r^2 values of 0.99 for each cruise. Differences occurred mainly in regions with significant vertical gradients of salinity over the depth difference between the bottle sample and the deeper CTD sample, suggesting the same waters were not sampled. These were mainly at near-shore, shallow, river-influenced stations.

Dissolved oxygen concentration versus sigma-theta for cruises N2, N3, N4 are shown in Figure 4.2.3. The dissolved oxygen concentrations behaved as expected, with most variability in the less dense upper water than in the denser deep water. Note the oxygen minimum at about 27.15 or 27.10 $kg \cdot m^{-3}$.

4.3 Acoustic Doppler Current Profiler Measurements

QA/QC processing of ADCP data was described in detail in Section 4.4 of Jochens and Nowlin (1998). A brief summary is given here, with results for cruises N2 through N4.

4.3.1 Standard ADCP Processing

ADCP data are recorded using the RDI TRANSECT software, which also logs the DGPS navigation data to a separate file. TRANSECT records raw binary ADCP data, averages the data into 5-minute segments, and converts the averaged data into ASCII format. ADCP data next are

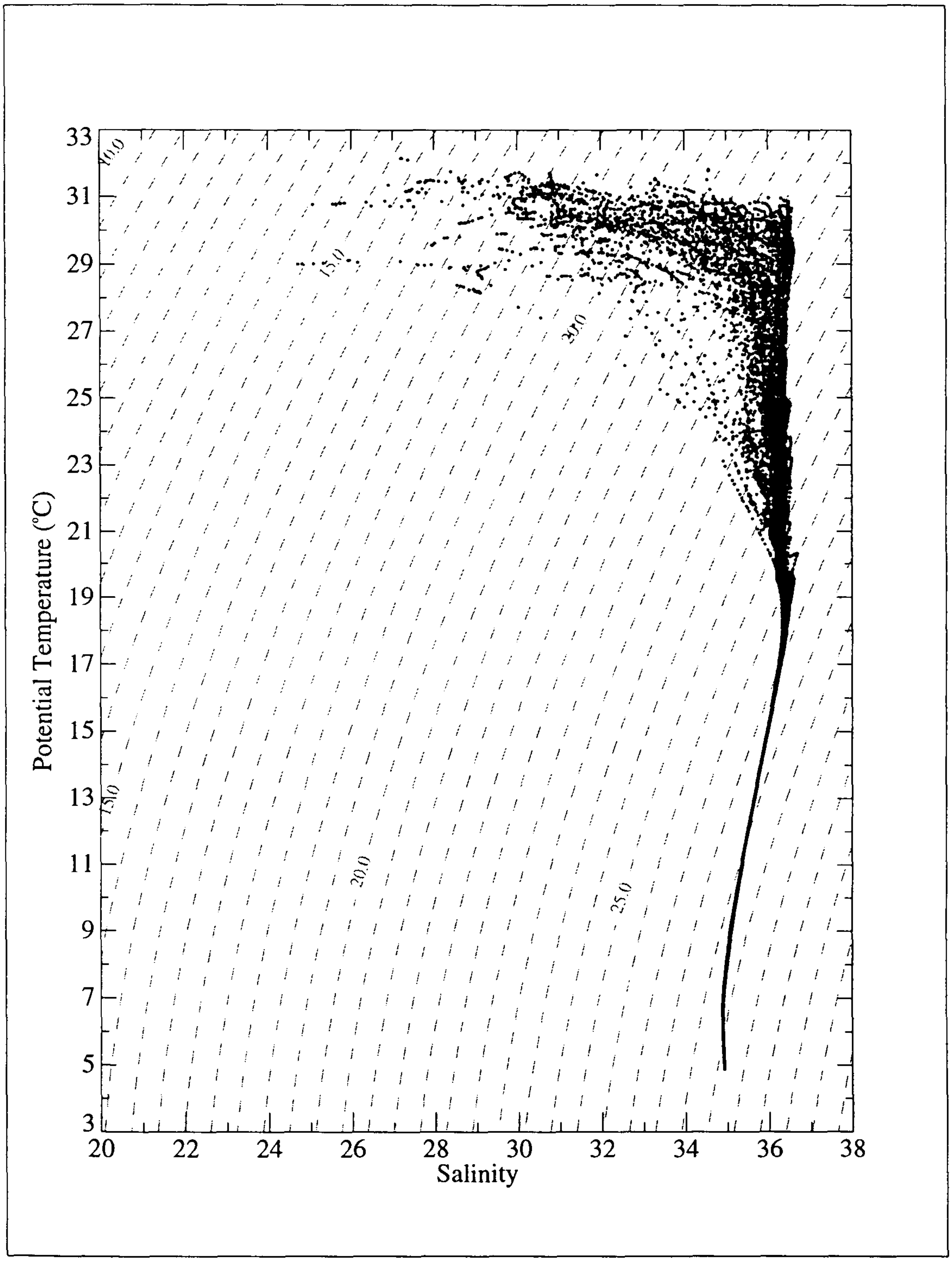


Figure 4.1.1. Composite potential temperature–salinity diagram for stations from cruise N3 (July/August 1998). The minimum salinity was 24.715.

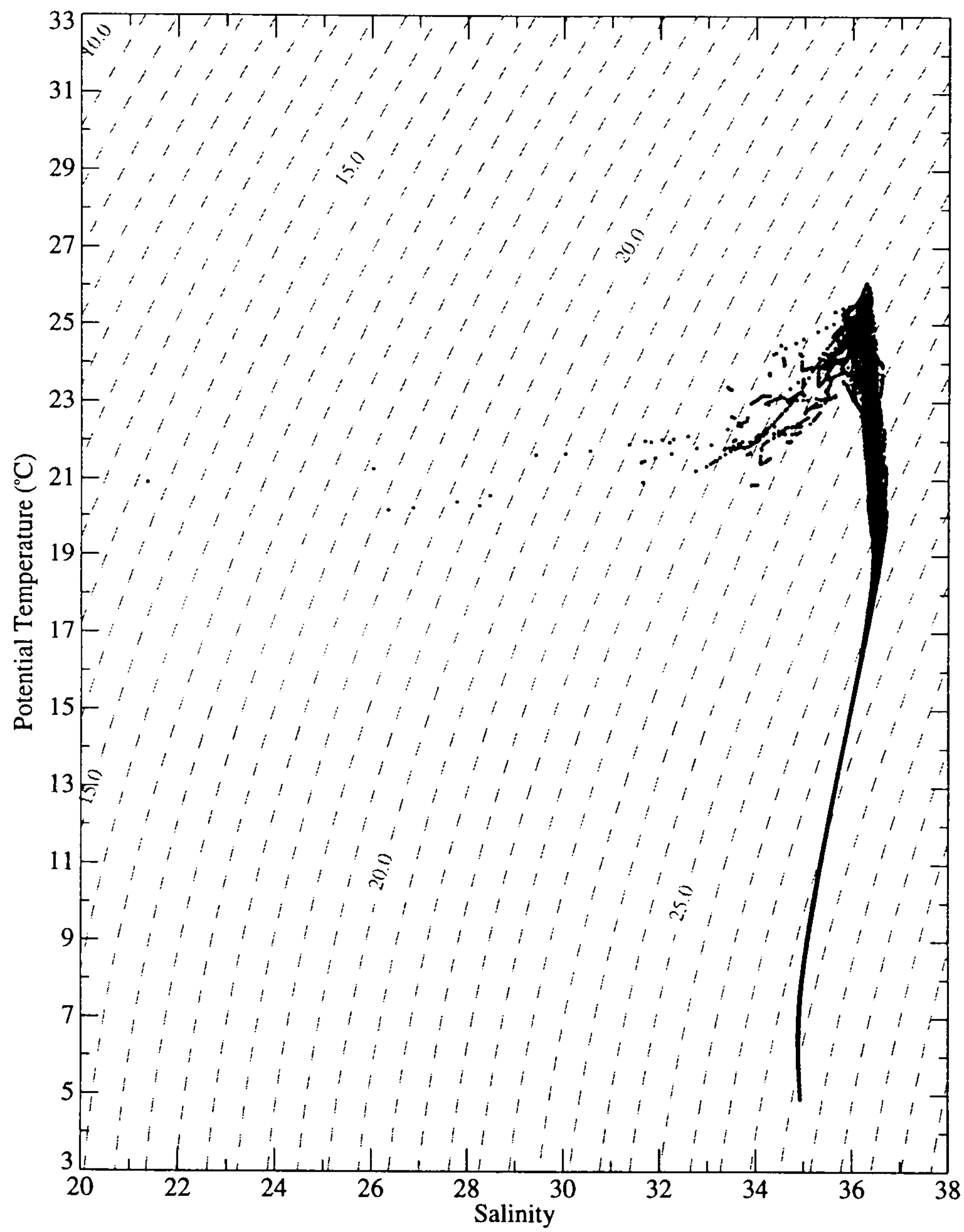


Figure 4.1.2. Composite potential temperature–salinity diagram for stations from cruise N4 (November 1998). The minimum salinity was 15.236.

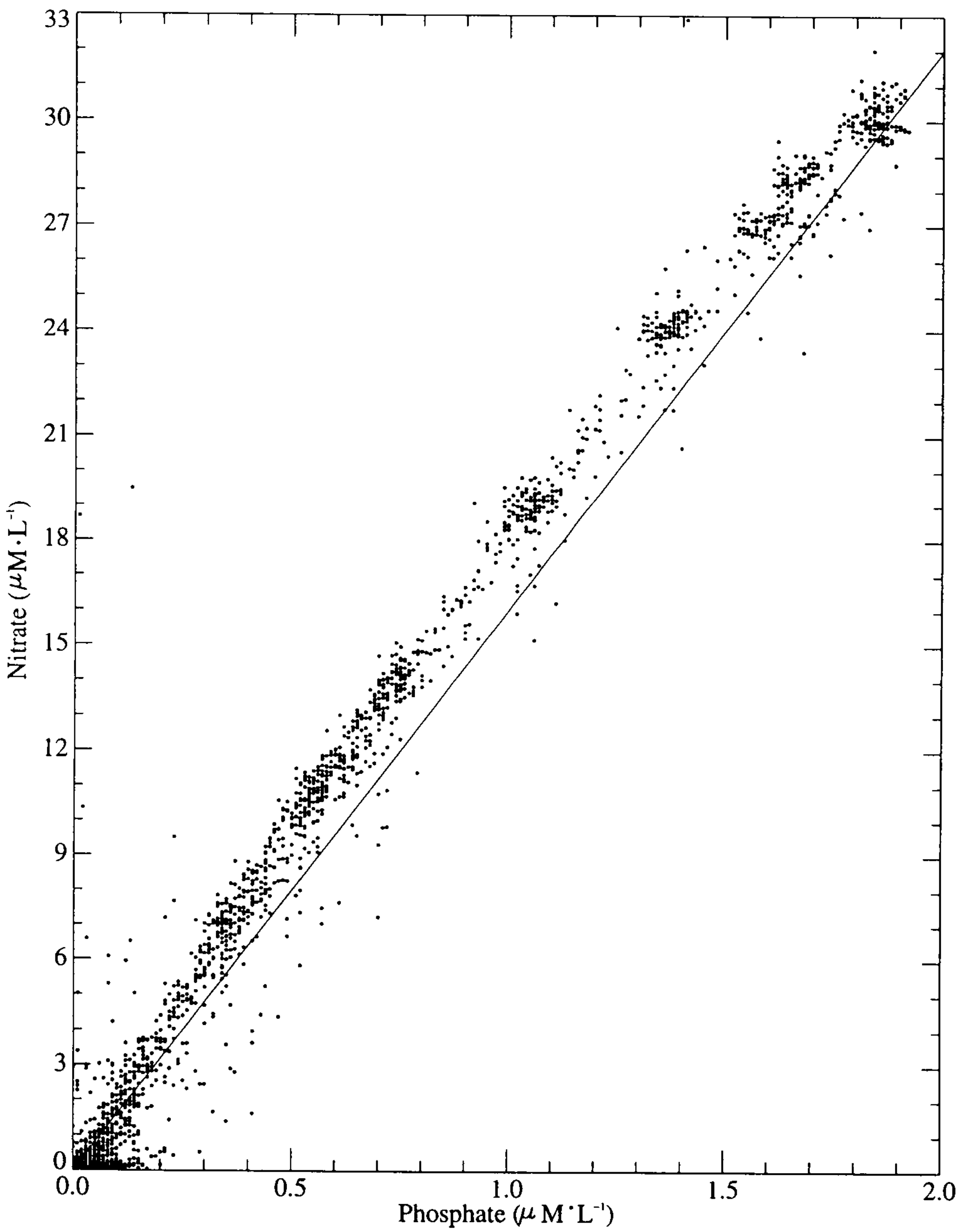


Figure 4.2.1. Phosphate versus nitrate for 1998 cruises N2 (spring), N3 (summer), and N4 (fall). The line represents the Redfield ratio of N:P (16:1).

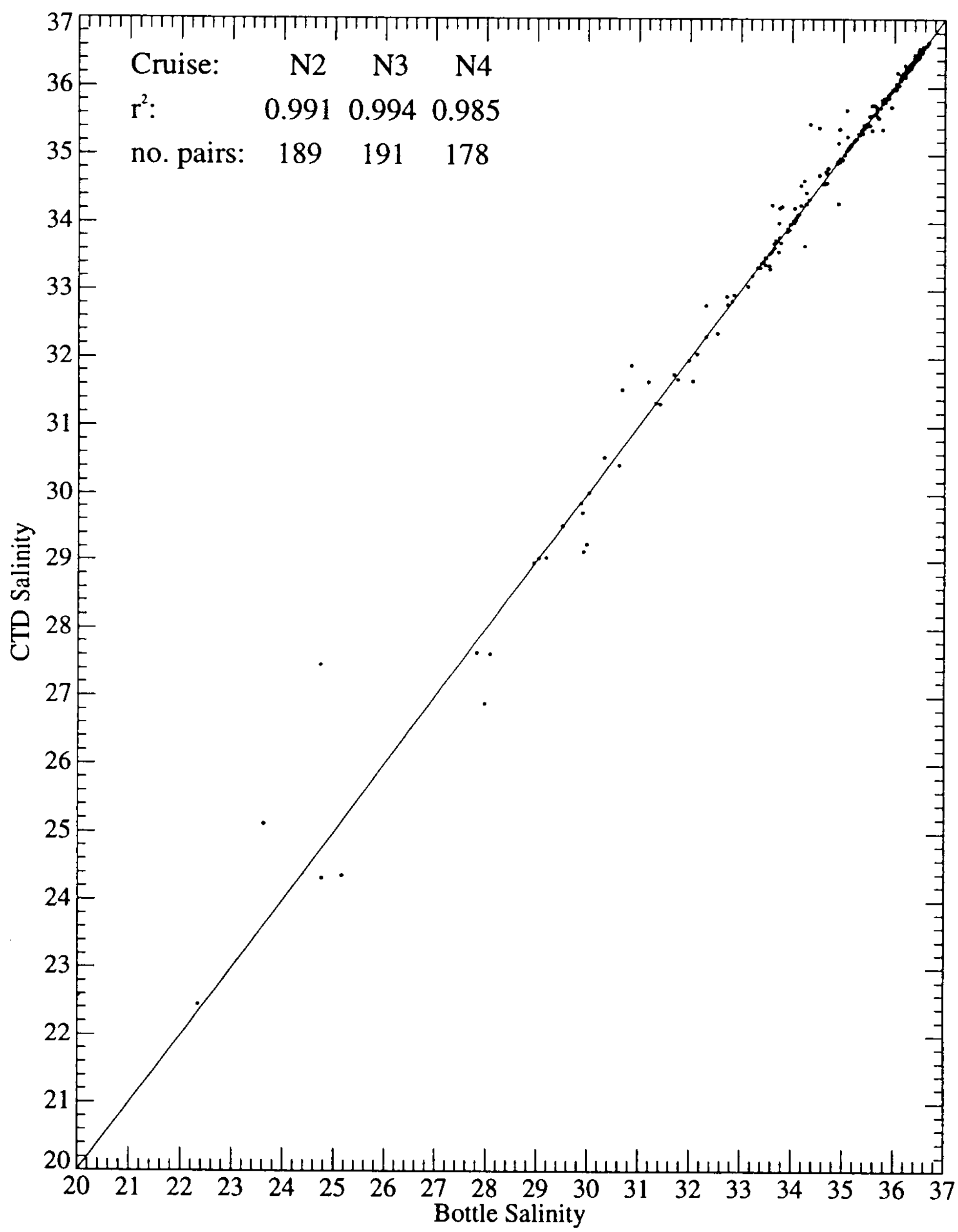


Figure 4.2.2. Ensemble upcast CTD salinity versus bottle salinity for 1998 cruises N2 (spring), N3 (summer), and N4 (fall).

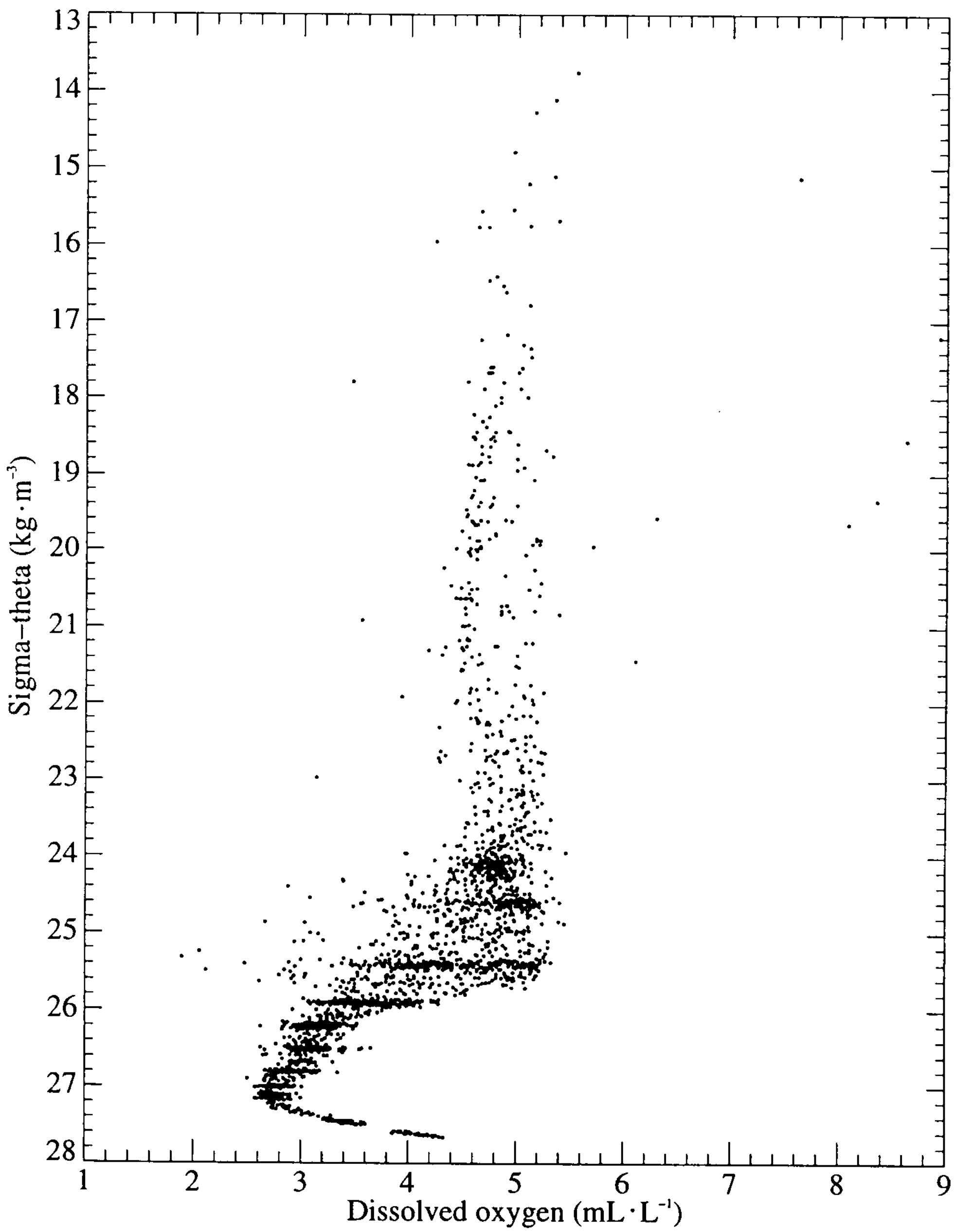


Figure 4.2.3. Dissolved oxygen versus upcast sigma–theta for 1998 cruises N2 (spring), N3 (summer), and N4 (fall).

merged with navigation data. The ship velocity is subtracted from the raw ADCP measurements to obtain the current velocity. DGPS ship velocity is used for the calculation in deep water while bottom-track ship velocity is used in shallow water. That subset of the data having both bottom-track and navigation velocities is used to perform a calibration of the ADCP after the manner of Joyce (1989). The complex regression statistics for the bottom-track versus GPS navigation velocities and the average DGPS ship speed are summarized in Table 4.3.1. These show the regression angle and modulus fall within typical values of mean alignment error (1-2 degrees) and sensitivity error (1.00 to 1.04) for the *R/V Gyre*. After navigation data are merged with ADCP data, data are inspected for additional problems and bad data segments are removed or flagged. The results of this step are summarized in Table 4.3.2.

Table 4.3.1. Complex regression statistics for GPS velocity versus bottom-track velocity on cruises N2 through N4.

Description	**N2**	**N3**	**N4**
Stations for misalignment angle	2082	2343	482
Sample size used	8673	11119	1837
Clockwise regression angle (α)	-2.417116	-2.0498	-1.2924
Regression modulus (b_m)	0.996156	1.000113	1.002139
Coherence parameter (ρ^2)	0.96684	0.95039	0.92740
Average GPS ship speed ($cm{\cdot}s^{-1}$)	466.5	453.5	428.4

Table 4.3.2. Results of evaluation of ADCP data for external factors on cruises N2 through N4 and number of data segments rejected.

Description	N2	N3	N4
Total number of segments	3071	3572	810
Segments rejected for no navigation data	61	65	14
Segments rejected for insufficient beams	0	0	13
Segments rejected for bottom-track depth too shallow	43	261	9
Segments rejected for slow ship speed (< 100 $cm \cdot s^{-1}$)	682	640	162
Segments rejected for fast ship speed (> 650 $cm \cdot s^{-1}$)	0	0	0
Segments rejected for % of good pings in first bin < 30	57	49	10
Preliminary number of usable segments	2228	2557	594
Segments rejected for bad navigation data	146	214	112
Segments rejected for outliers	246	420	66
Final number of usable segments	1836	1923	416

4.3.2 New Ensemble Processing Procedure

To improve the overall data quality and to recover segment data eliminated because of bad pings, special in-house processing software was developed for the broad-band ADCP. The Ashtech ADU2 3DF positioning antenna array (Section 3.2.3) collected high-precision positioning information that allowed these additional quality control procedures. The array provides more accurate attitude (pitch, roll, heading) information than the ship's Sperry gyrocompass. Ashtech data are used for special processing of the individual 8- to 10-second ensembles that are averaged together to make the 5-minute segments. Ensembles are composed of four 2-second pings, of which two are used for bottom tracking. The remaining two are averaged together to estimate current velocity. In the original processing method, all ensembles are automatically averaged into 5-minute segments for further processing by the TRANSECT software. Our experience with shipboard ADCP data, however, has shown that occasionally one or more ensembles in a segment have unrealistic or bad values that result in the removal of an entire 5-minute averaged segment. By quality controlling and discarding bad ensembles prior to averaging into 5-minute bins, the data quality is substantially increased.

The ensemble processing requires high-precision position information, because each 8-second ensemble must be corrected for ship speed as opposed to each 5-minute segment, where it is only necessary to determine the ship's velocity using the navigation data recorded at the beginning and end of a 5-minute segment. Because the ship moves only a small distance during the ensemble relative to during a segment, it is important to obtain accurate ship positions to within a meter. The ship's position is recorded by differential GPS at a 1 Hz sampling rate to get a reliable average ship speed during the 8-second ensemble. To illustrate, consider a ship traveling at 400 cm·s^{-1}. The ship would move 32 m during one ensemble, but would move 1200 m during one segment. It is easy to see how position resolution of several meters would hardly affect the accuracy of ship velocity during a segment, but could greatly affect the velocity estimate during an ensemble.

After a reliable estimate is obtained for the ship velocity, it is then subtracted from the ADCP transducer velocity to get current velocity in the same way as described in Jochens and Nowlin (1998). The resulting current velocity ensembles are then quality controlled using the percent good flag. Because only two pings are used per ensemble the percent good flag is either 0 - both pings bad, 50 - one good, one bad ping, or 100 - both pings good. Any ensemble less than 100% good is discarded. The resulting quality controlled ensembles are then binned into 5-minute averaged segments. Joyce parameters are also determined.

A by-product of the ensemble processing is the ability to quality control ADCP data when the ship is on station. Previously, these data were discarded because of unreliable ship heading and errors in the 5-minute data due to ship acceleration and deceleration when approaching and leaving a station. It is believed that the ensemble processing greatly enhances the quality and reliability of the NEGOM ADCP data set. The ensemble processing also will lead to removal of slow ship speed criterion for excluding segments.

Cruise N3 ADCP data have been ensemble processed. Testing and refinement of the ensemble procedures are still in progress.

4.3.3 Results of QA/QC for N2 through N4

Cruise N2: There were no collection problems during the N2 cruise. The dominant problem encountered was identified during data processing and was caused by a systematic offset in the gyrocompass directional data. A sinusoidal drift in the angular alignment parameter was discovered. The drift was quantified by estimating the mean alignment error for each cross-shelf transect. In this way, the alignment error as a function of ship's heading was estimated. The misalignment error ranged from 0.5° for a southward heading to -3.6° for a northward heading. The ADCP data then were corrected using this relationship rather than using a single alignment error value for the whole cruise. The problem was caused by excessive wear in the bearings of the gyroscope. A complete refurbishment of the gyrocompass in June 1998 fixed this problem. Data from N3 and N4 were specifically analyzed for reoccurrence of this problem and data from N1 were reanalyzed to be certain the problem did not exist in those data as well. There was no evidence of this problem during those cruises. There was no heading dependence found for the sensitivity Joyce parameter.

Cruise N3: The Ashtech data were recorded separately from the standard navigation stream and had to be treated separately when merging with the ensemble data. This changed in future cruises when Ashtech data were fed directly into the same file containing the standard navigation stream. There were no other significant problems with the broad-band data collection or processing.

Cruise N4: Early in the cruise the broadband ADCP was damaged (Section 3.2.3). The back-up narrow-band ADCP replaced the broadband after a diver was commissioned to inspect and help remove the broad-band instrument from the instrument well. This occurred near line 4, so only the west portion of the shelf was measured with the ADCP.

A 38 kHz broad-band ADCP was loaned to TAMU for testing and placed in the aft moon pool of the *R/V Gyre*. It was thought that this instrument might supplement the data collection by the 150 kHz broadband and provide data to nominally 700 m depth. However, engine noise overwhelmed the acoustic signal. Multiple tests while at sea provided useful diagnostic information for trouble shooting the mechanisms of noise contamination, but no immediate solutions were apparent. Tests included switching the instrument from broad-band mode to narrow-band mode and recording ADCP data at various ship speeds, including adrift with the engines declutched and turned off. No usable data was obtained from the 38 kHz ADCP.

4.4 XBT Measurements

At the time of deployment, the XBT operator enters an event marker in the GERGNAV navigation computer. This records the UTC time and DGPS location at the time of the drop in a disk file. The operator also records a bottom depth reading provided by bridge personnel, the location, and the temperature and salinity from the flow-through system on the paper copy of the XBT profile. This hand-written information provides a check against the digital data. The binary format files are converted to ASCII using Sippican software. The ASCII files are plotted and inspected by eye for reasonableness. The first three data points are discarded as they show clear evidence that the probe has not come into equilibrium yet. Data collected after an active probe reaches the seafloor also are removed. While this depth is frequently obvious from the temperature record, corrected fathometer depths are used to truncate the records when needed.

The depths generated by Sippican software are not used for the XBT QA/QC processing. Sippican-generated depths are determined by an old drop-rate formula known to be in error. Newer, more accurate drop rates formulas have been determined empirically by careful comparison between CTD and XBT profiles (e.g., Hanawa et al., 1995). The Hanawa formulation is used to produce a new depth series for each probe. The corrected fathometer depth is compared to the new depth data to determine where to truncate the data. Standard practice is to report XBT temperature profiles using the provided Sippican generated depths; the users are expected to correct the Sippican depths using the current accepted drop rate formulae.

4.5 Underway Measurements

Chlorophyll computed from fluorescence obtained from a flow-through fluorometer generally agreed with the extracted chlorophyll to ±0.05 $\mu g{\cdot}L^{-1}$ or better in low chlorophyll, bio-optical

Type II environments and to ± 0.2 $\mu g \cdot L^{-1}$ or better in high chlorophyll, bio-optical Type I environments on each of cruises N3, N4, and N5. Figures 4.5.1, 4.5.2, and 4.5.3 summarize these calibration data for summer 1998, fall 1998, and spring 1999 cruises. The exception was fall cruise N4, when extracted chlorophyll was anomalously lower than flow-through fluorescence at a number of locations in both Type II and Type I water. Three outlier high-fluorescence, low-chlorophyll points were excluded from the N4 Type I water calibration curve, and 18 high-fluorescence, low-chlorophyll points were excluded from the N4 Type II water calibration curve (Figure 4.5.2). Some of the high fluorescence at these locations apparently resulted from colored dissolved organic matter (CDOM) as well as from chlorophyll.

In general, sea surface chlorophyll (SSC) showed a strong inverse correlation with sea surface salinity (SSS), since low salinity is usually a proxy for high nitrate and phosphate concentrations in surface water of coastal and estuarine origin. On each of cruises N2, N3, and N4 (as well as on cruise N1, summarized in Jochens and Nowlin (1998)), locally low salinity water usually had high chlorophyll, and vice versa. Where SSS was < 32, SSC was usually > 0.5 $\mu g \cdot L^{-1}$. The contour plots for cruises N2 through N4, discussed below, illustrate this point.

Cruise N2: SSC was low (< 0.1 $\mu g \cdot L^{-1}$) and SSS was high (> 34) seaward of the 100-m isobath along lines 8 through 11 (Figure 4.5.4). This is the region where altimetry (sea surface height anomaly data) and ship data (geopotential anomaly data) show that a secondary warm eddy was present, with weakly anticyclonic (convergent) surface circulation. In contrast, along lines 1 through 3 to the west was a region of lower SSS, below which the nitracline was often locally shallow as well. In this western part of the NEGOM field region, SSC was two-fold or more higher. Locally highest SSC values (> 1 $\mu g \cdot L^{-1}$) were associated with low SSS flowing out of Mobile Bay, Mississippi Sound, Pass a Loutre, and the South West Pass of the Mississippi River Delta.

Cruise N3: SSS was lower than 32 along the continental slope throughout the field area, and SSC was generally > 0.5 $\mu g \cdot L^{-1}$ (Figure 4.5.5). Waters with the lowest SSS (27-28) were encountered over the slope along lines 6 and 7. These had SSC concentrations of > 1 $\mu g \cdot L^{-1}$. This low- salinity, high-chlorophyll surface water appears to be Mississippi River water that had been entrained into the anticyclonic circulation about the warm ringlet that was centered over DeSoto Canyon some days to weeks before the cruise. Water with similar SSS and SSC characteristics was encountered close off the Mississippi River Delta on lines 1 and 2, but was no longer spatially coherent with that found along lines 6 and 7 at the time of the survey.

Cruise N4: On cruise N4, waters with SSS > 36 were found over most of the slope seaward of the 100-m isobath along lines 3 to 11 (Figure 4.5.6). Although this is quite high for surface salinity and typical of what is usually classed as oligotrophic, open-ocean water, the month of November is the time of year in which the seasonal cycle of SSC in Type II water begins to increase (Muller-Karger et al., 1991). On this cruise, SSC in this Type II water everywhere exceeded 0.1 $\mu g \cdot L^{-1}$, ranging to 0.3 $\mu g \cdot L^{-1}$. The highest concentrations of SSC were found inshore, over the inner shelf of the Florida Bight, off Mobile Bay, and close off the Mississippi

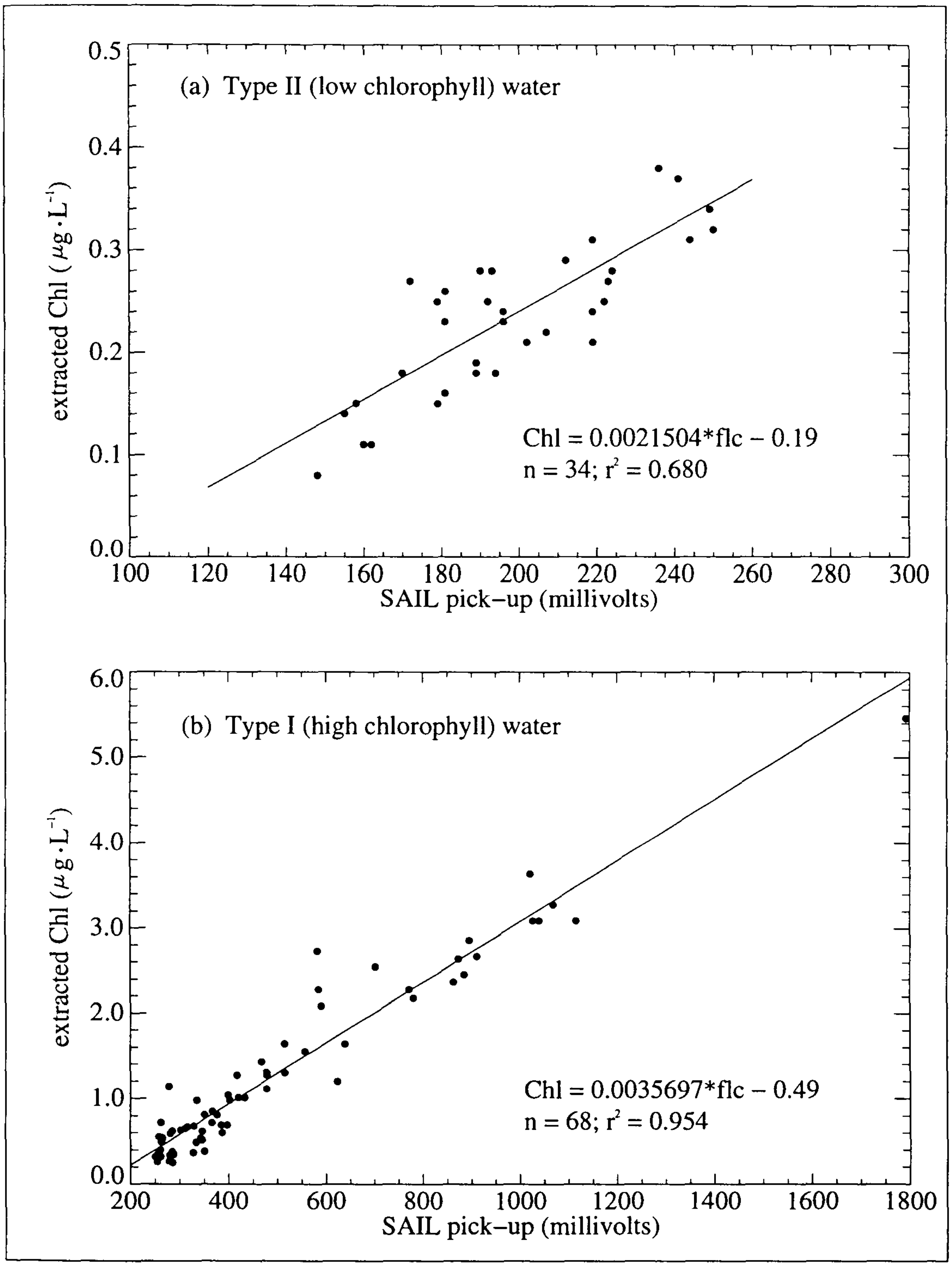


Figure 4.5.1. Flow–through fluorometer calibration for cruise N3 (July/August 1998).

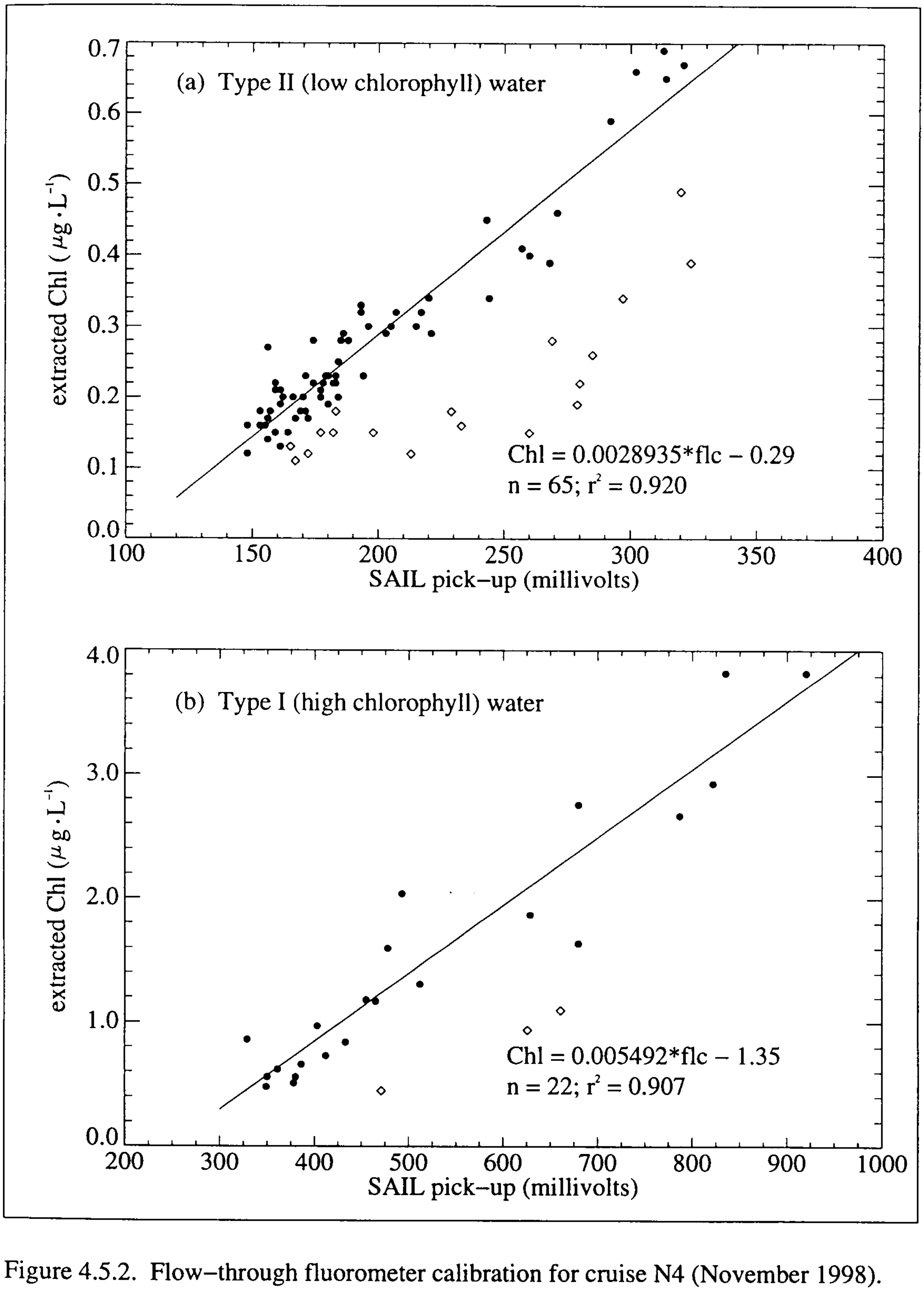


Figure 4.5.2. Flow–through fluorometer calibration for cruise N4 (November 1998). Diamonds denote outliers that were not used in the calibrations.

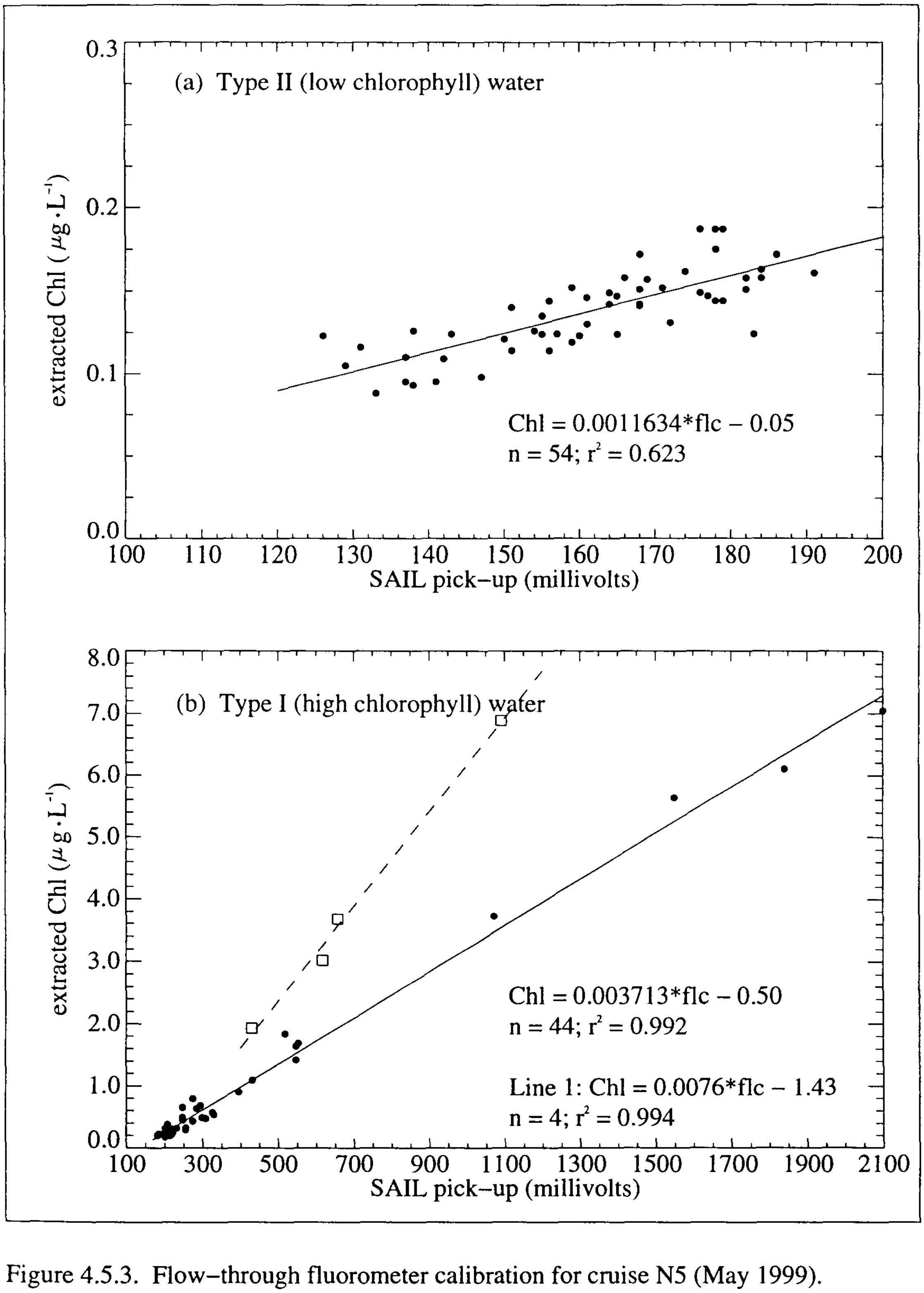


Figure 4.5.3. Flow–through fluorometer calibration for cruise N5 (May 1999).
Dashed line is for the Line 1 data (diamonds).

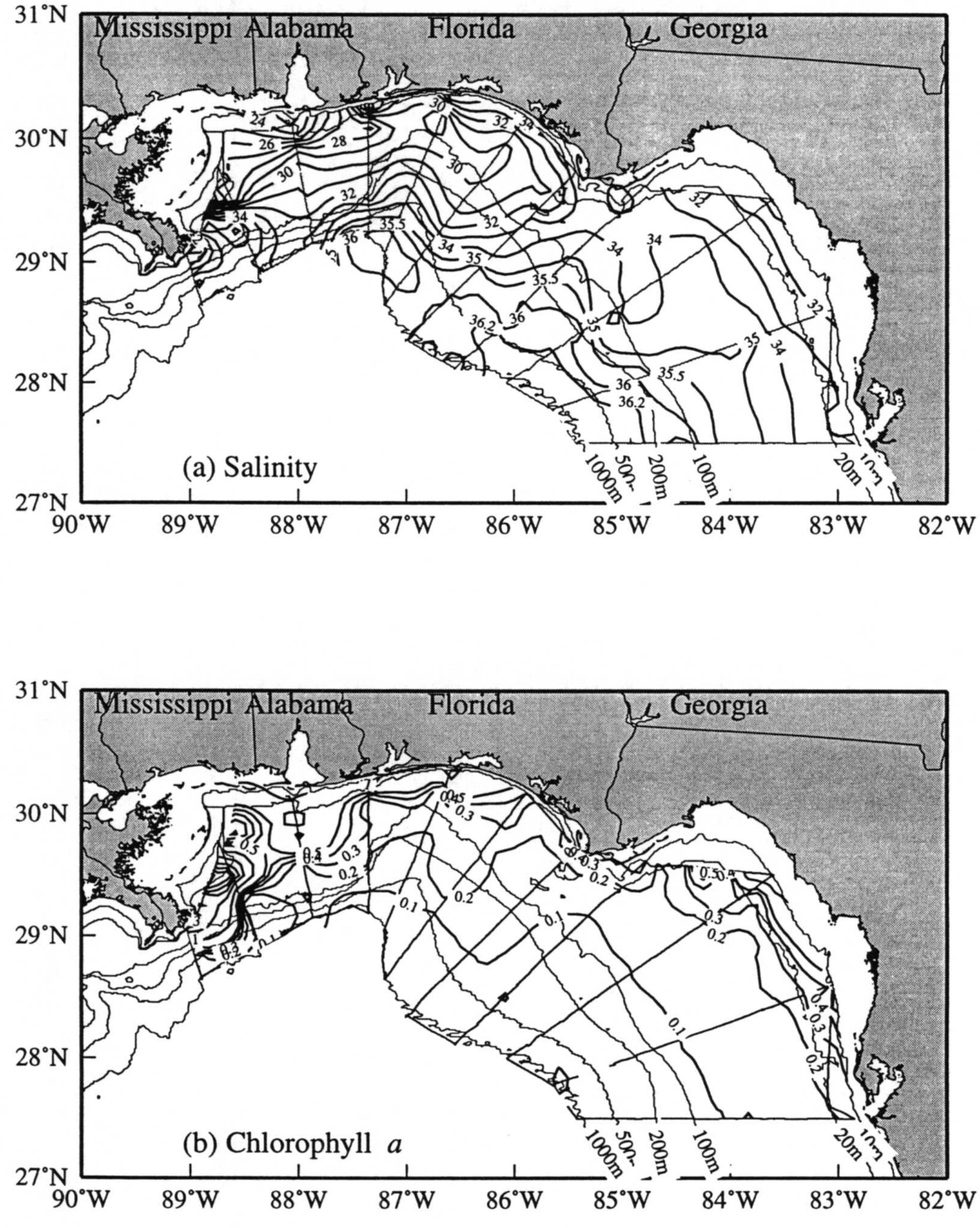


Figure 4.5.4. Salinity and chlorophyll *a* at about 3-m depth on cruise N2 (May 1998). Salinity observations were from the thermosalinograph; chlorophyll *a* was calculated from the flow-through fluorescence.

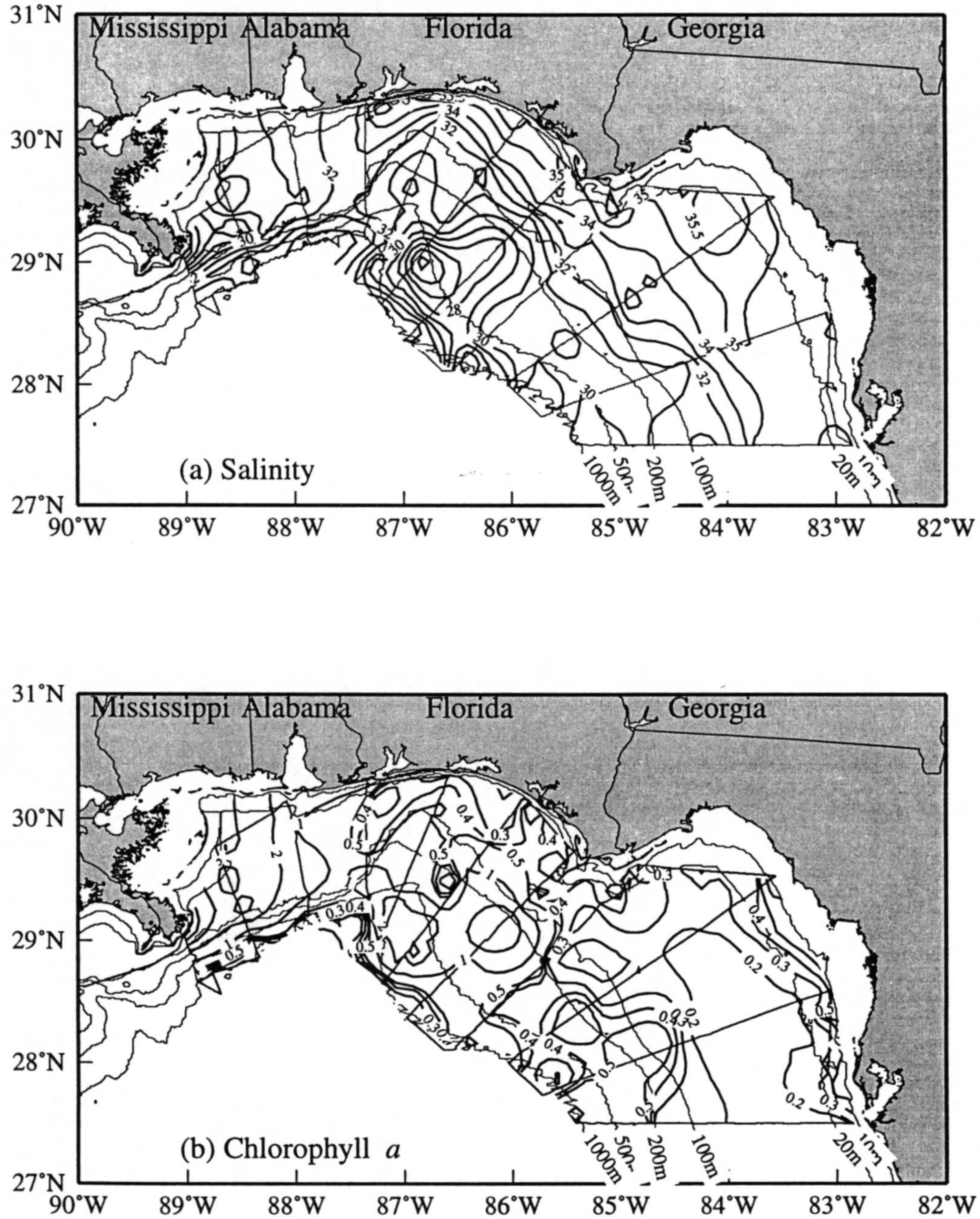


Figure 4.5.5. Salinity and chlorophyll *a* at about 3-m depth on cruise N3 (July/August 1998). Salinity observations were from the thermosalinograph; chlorophyll *a* was calculated from the flow-through fluorescence.

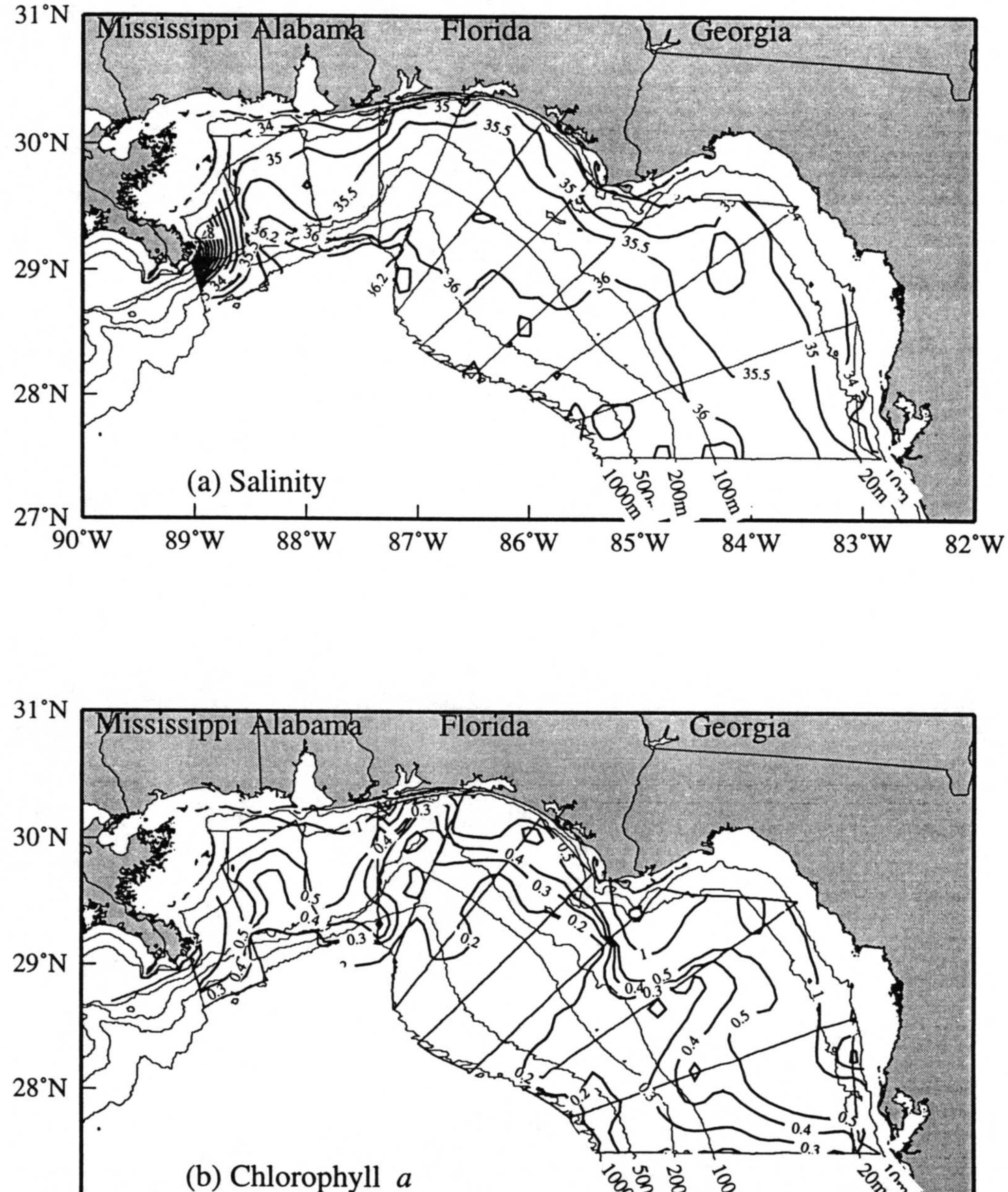


Figure 4.5.6. Salinity and chlorophyll *a* at about 3-m depth on cruise N4 (November 1998). Salinity observations were from the thermosalinograph; chlorophyll *a* was calculated from the flow-through fluorescence.

River Delta. The SSS and SSC fields on N4 from November 1998 are quite similar to those on N1 from November 1997. In both years, SSS < 32 was restricted to the area close-in to the Mississippi River Delta, and SSC seaward of the middle shelf generally ranged between 0.2 $\mu g \cdot L^{-1}$ and 0.5 $\mu g \cdot L^{-1}$.

5 TECHNICAL DISCUSSION

Section 5 provides a brief technical discussion of forcing functions during cruises N1 through N4 (Section 5.1) and an overview of the integrated water column chemistry for cruises N1 through N4 (Section 5.2). Near-surface in this section refers to data from about the 3.5-m depth. Detailed syntheses and interpretations will be included in the Final Synthesis Report for this project. Although the data shown in this section have received quality control and assessment, they are still preliminary; users should expect that subsequent corrections will be made to the data sets prior to the conclusion of the project. This same caveat applies to all data reported in this document.

5.1 Forcing Functions

Ancillary data sets are being acquired to allow examination of various forcing functions that influence water properties and circulation in the NEGOM study area. These include meteorological data from marine buoys and coastal land stations, river discharge rates, and sea surface height anomaly fields from satellite altimeters. Some key points regarding the forcing functions at the time of each of the first four cruises are described below. The order of their consideration is wind, river discharge, and eddy-shelf interactions.

5.1.1 Wind

Meteorological data from offshore buoys and coastal land stations are being acquired. These data include wind speed and direction, air temperature, and barometric pressure. Wind data are treated in two ways: conversion to alongshelf and cross-shelf components and conversion to gridded wind field products. For this report, a description of the preliminary gridded wind fields for the four cruise periods is presented.

Hourly winds for November 1997 through November 1998 from 13 sites within and bounding the study area were used to compute gridded hourly winds at 1/2° x 1/2° resolution. Hourly fields of wind components were estimated at each grid point by a statistical optimal interpolation method. Squared-correlation coefficients confirmed a strong correlation between the observed and gridded components. Monthly mean fields were computed by averaging hourly data over a one-month period at each grid point. Gridded wind vectors at 0700 UTC were produced for each day of the four cruises. Additionally, the *Daily Weather Maps* of NOAA's Climate Prediction Center were inspected to identify frontal passages through the NEGOM study area during the cruises. Note this summary of daily wind speeds and directions is limited to the 0700 UTC winds.

N1: Monthly mean winds were weak ($< 5\ m \cdot s^{-1}$) and generally directed to the south or southwest over the study area in November 1997. Throughout most of the N1 cruise, winds were directed to the south and southwest, in response to the presence of high pressure over the continent to the north. These winds varied approximately between 5 and 10 $m \cdot s^{-1}$, with the western shelf experiencing stronger winds than the eastern shelf. From November 21-23, however, low pressure was located over the adjacent continent and a front passed over the study area on November 22. The winds in the study area responded mainly by changing their direction to the north and northeast; speeds generally were < 10 $m \cdot s^{-1}$.

N2: In May 1998, monthly mean winds were weak and directed to the northeast. During the N2 cruise, winds were usually 5-10 $m \cdot s^{-1}$ during the first half of the cruise and $\leq$ 5 $m \cdot s^{-1}$ during the second half. They were directed generally between northwest and northeast, although the east shelf experienced winds to the south and southeast in the last half of the cruise. There were several periods with upwelling-favorable (though weak) westerly winds, particularly near-shore. Frontal passages went through the area just prior to the cruise and about May 10-11, with the winds changing from southerly to northerly.

N3: Monthly mean winds in July/August 1998 were mixed; in July they were directed east-northeast and were about 3-4 $m \cdot s^{-1}$, while in August they were directed north-northwest and were < 4 $m \cdot s^{-1}$. Weak westerly winds occurred during the July portion of cruise N3, when high pressure was over the northeast Gulf. During 2-5 August, a stationary front dominated the area with easterly winds ~5 to 10 $m \cdot s^{-1}$ in the west and weaker in the east.

N4: November 1998 monthly mean winds were weak, particularly in the east area, and generally were toward the southwest to west. Wind directions were variable during cruise N4; speeds ranged from very small to ~10 $m \cdot s^{-1}$. A cold front, moving west to east, passed over the area on 21 November. The effect was to shift the direction of the winds from southerly to northerly as shown in the gridded wind field for 0700 UTC 21 November 1998 (Figure 5.1.1 a). Note that, at the time of this plot, the front had just crossed into the far west portion of the study area and the eastern shelf was not yet affected. By November 22nd, the cold front had passed over the area and, with high pressure over the eastern U.S., the winds in the study area had shifted to the southwest at 5 to 10 $m \cdot s^{-1}$ (Figure 5.1.1 b).

5.1.2 River Discharge

Historical river discharge rates were obtained for the larger rivers in the region from the Mississippi River to the Suwannee River. Long-term means of daily discharge were compared with the discharge rates for 1998. During winter 1998, discharge from all rivers in the region exceeded the long-term mean by significant amounts. In spring, the Mississippi continued to discharge at well above its mean rate, as shown in Figure 5.1.2 a (the long-term mean and standard deviation are based on a 64-year record). Other rivers had flows below their means with one significant exception. In late April, rivers from the Pearl to Apalachicola exhibited a brief pulse of much greater than average discharge—in some cases significantly exceeding the mean plus one standard deviation. This pattern is illustrated in Figure 5.1.2 b, showing daily discharge rates for the Tombigbee River; the long-term mean and standard deviation are based on the 70-year record. Major rivers examined east of Cape San Blas generally had only one

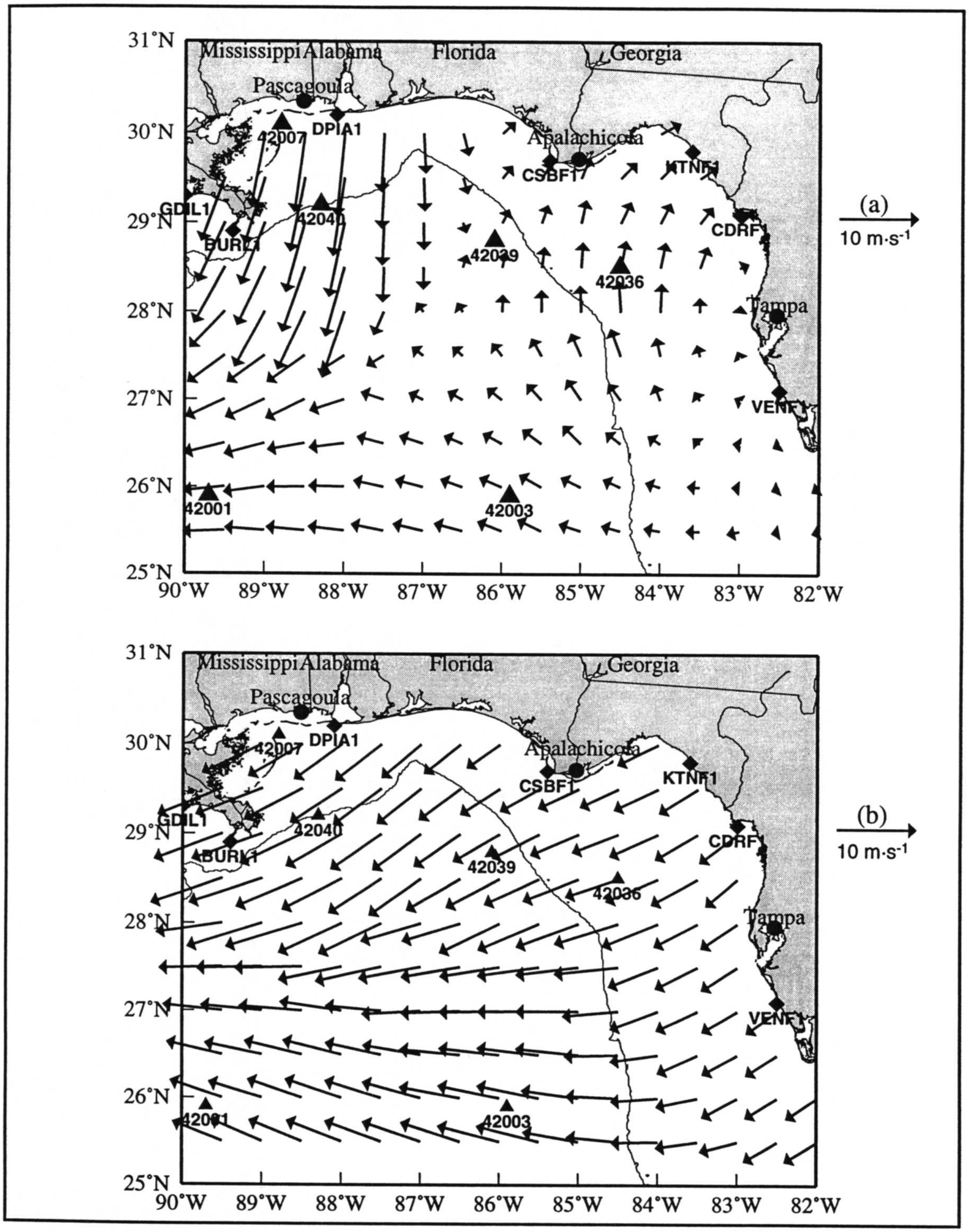


Figure 5.1.1. Wind vector field at 0700 UTC on (a) 21 November 1998 and (b) 22 November 1998. Triangles indicate NDBC buoy stations; diamonds C-MAN buoy stations. The 200-m isobath is shown.

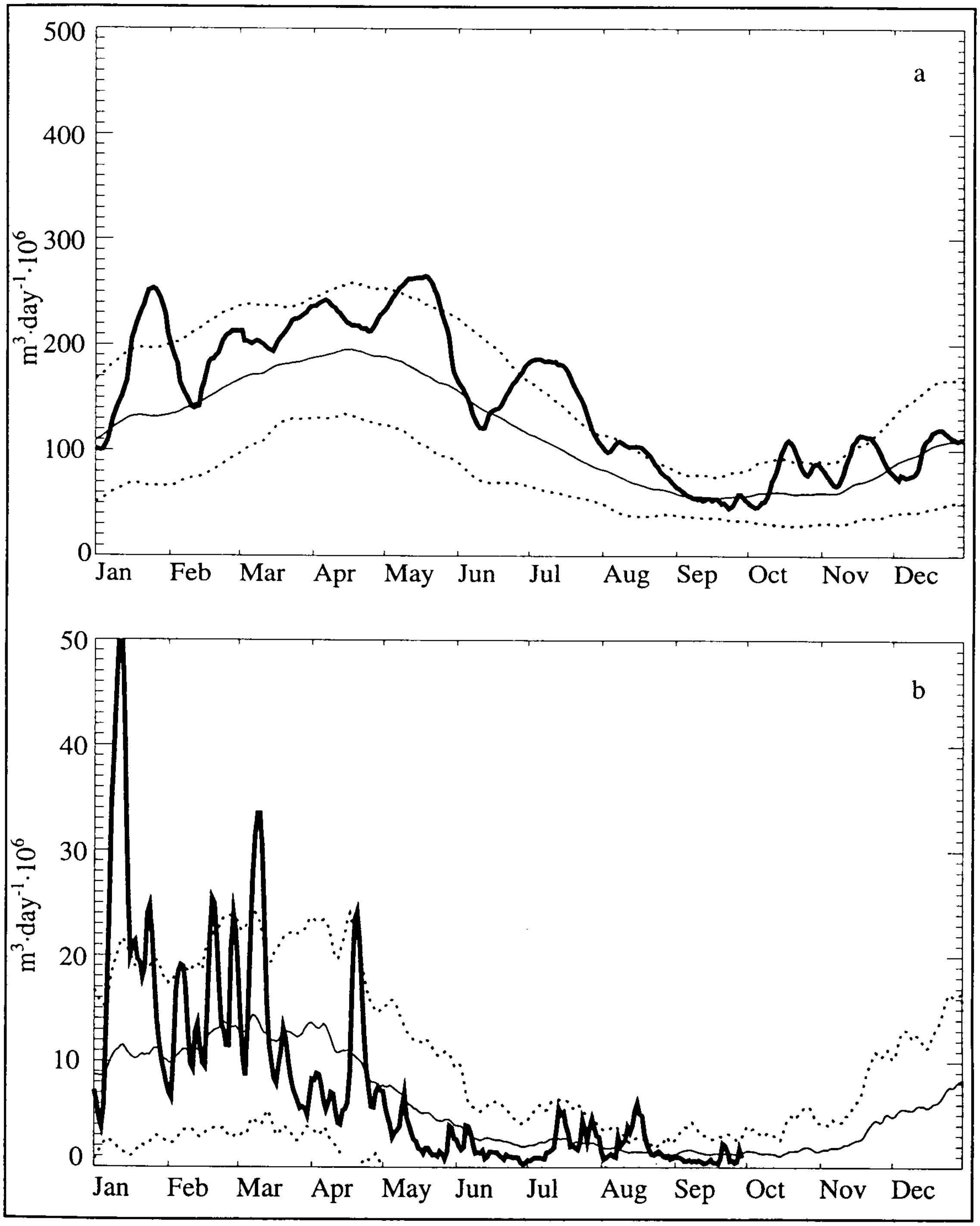


Figure 5.1.2. Daily discharge rates for the (a) Mississippi River at Tarbert Landing (64-yr record) and (b) Tombigbee River at Demopolis, AL (70-yr record). Thin solid line shows the long-term mean. Dotted lines show one standard deviation from the mean. Thick solid line shows the 1998 discharge rate.

episode (in March) of very high (relative to the mean) discharge during the first half of 1998. Greater than average river discharge into the Gulf from Mississippi Sound to Cape San Blas during early 1998 is consistent with the extensive surface expression of fresh water observed during cruise N2 in May 1998.

5.1.3 Eddy-Shelf Interactions

Cyclonic and anticyclonic eddies in deep water near the shelf have profound influence on the outer shelf circulation in the northeastern Gulf. Here are summarized the features present in the SSHA fields during cruises N1 through N4. Temporal development of these features was examined through the evolution of sea surface height anomaly (SSHA) over the northeastern Gulf, offshore of the 200-m isobath, using a product prepared by Dr. Robert R. Leben (University of Colorado) based on a combination of altimeter data from TOPEX/POSEIDON and ERS-2. The time series consisted of one SSHA field per week beginning with 1 October 1997 and continuing through 30 December 1998. These SSHA distributions are from data sets that were temporally and spatially smoothed using decorrelation scales of 12 days and 100 km. Therefore, features may appear weaker then they were and smaller scale features may have been removed.

N1: During N1, an anticyclonic eddy was centered southeast of Southeast Pass and was elongated to extend into DeSoto Canyon (Figure 5.1.3 a). This eddy was responsible for anticyclonic offshore circulation and intrusions of warm, salty water across the western slope and onto the shelf at and west of the Mississippi River Delta (Jochens and Nowlin, 1998). The eastern shelf was under the influence of cyclonic flow. The strong cyclonic eddy to the south of the anticyclone, may have contributed to the northward advection of warm, salty water along its eastern edge.

N2: In spring 1998, the off-shelf area was under the influence of cyclonic flow except for two small anticyclones, one over DeSoto Canyon and another encroaching over the outer shelf edge west of Tampa. Just prior to the N2 cruise, these two small features coalesced; they strengthened during the cruise (Figure 5.1.3 b). Hydrographic and ADCP data taken during N2 corroborated these circulation features (Nowlin et al., 1998b).

N3: The coalesced feature strengthened during the summer and assumed an east-west orientation in the DeSoto Canyon region. During cruise N3, the anticyclone was centered at about 28.5°N, 87°W and was up against the 200-m isobath at about 88.75°W (Figure 5.1.4 a). The remainder of the outer shelf was under cyclonic flow. The anticyclone and the cyclonic flow to its north induced strong eastward flows along the shelf edge in the western study area. This likely carried the fresh water from the Mississippi River along the shelf edge, leading to a situation with fresher water offshore than nearshore.

N4: The eddy remained in the DeSoto Canyon region throughout the fall. In early fall, it weakened and elongated. By the time of cruise N4, it had intensified and developed into the

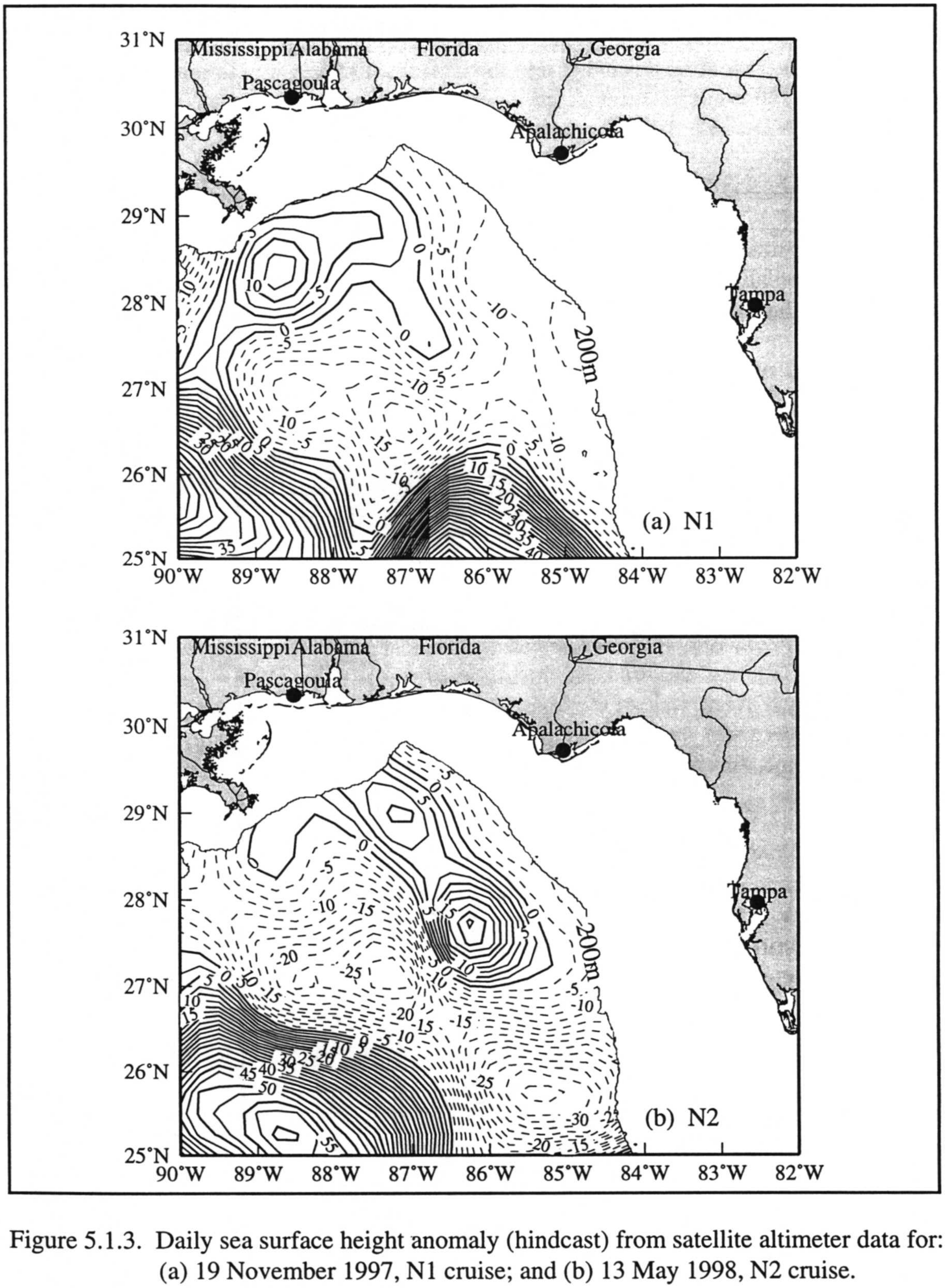


Figure 5.1.3. Daily sea surface height anomaly (hindcast) from satellite altimeter data for: (a) 19 November 1997, N1 cruise; and (b) 13 May 1998, N2 cruise. Contour interval is 2.5 cm.

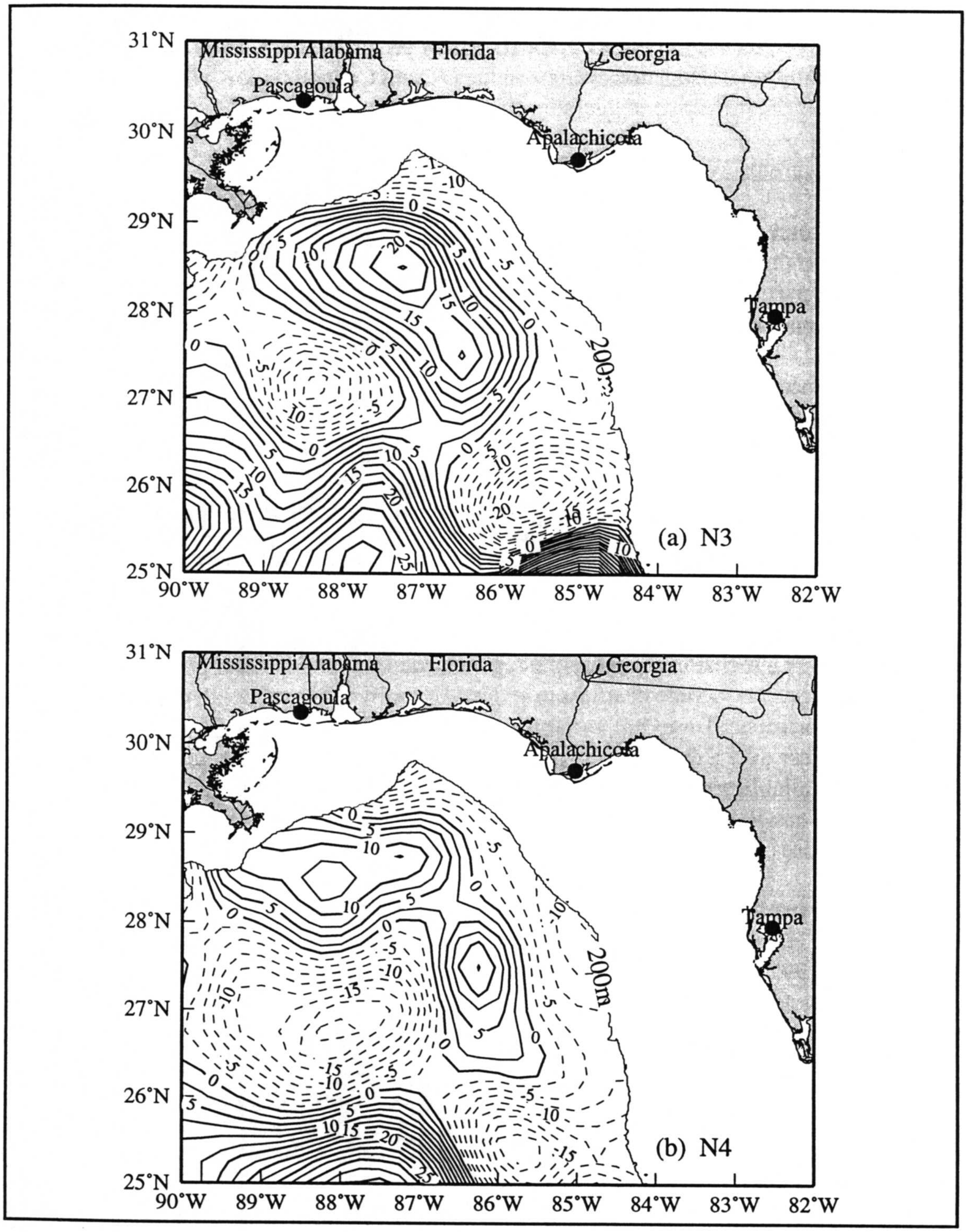


Figure 5.1.4. Daily sea surface height anomaly (hindcast) from satellite altimeter data for: (a) 29 July 1998, N3 cruise; and (b) 18 November 1998, N4 cruise. Contour interval is 2.5 cm.

shape with two highs seen in Figure 5.1.4 b. Again the far western study area was influenced by the anticyclone and associated cyclone in the DeSoto Canyon region, while the eastern shelf edge was under the influence of cyclonic flow.

5.2 Integrated Water Column Chemistry

The water column chemistry component is designed to provide an integrated understanding of the chemistry of the dissolved nutrients, oxygen, salinity, and particulate matter in the area. The dissolved and particulate fractions within the water column are closely coupled through the processes of photosynthesis, excretion, decomposition, and diagenesis. Nutrients (nitrate, phosphate, and silicate), oxygen, and salinity are dissolved water column constituents and are quantified by measuring concentrations. Particulate water column constituents are characterized as living and non-living, organic and inorganic, and phytoplankton-derived. Water column particulate matter is quantified as total mass (particulate matter, PM), particulate organic carbon (POC), and phytoplankton pigments in filtered particulates. The measurement program includes a combination of discrete sampling efforts and continuous monitoring with *in situ* detectors.

The water column chemistry component quantifies and describes how properties are established and altered in space and time in the study area. Observed concentration distributions are the result of inputs, outputs and transformations. Spatial variations in water column properties are observed in three dimensions by sampling regional transects and vertical profiles. The relevant spatial considerations include nearness to shore, proximity to rivers, depth in the water column, and regional location. Temporal variability is assessed by a time-series of sampling cruises three times a year over a three-year period. Seasonality in biological productivity (due to light and nutrient availability) and terrestrial inputs (rainfall and runoff patterns) is well known. The complete dataset will be analyzed to determine the relative importance of biogeochemical and physical processes in controlling and creating variability in water column properties.

5.2.1 Temperature

In November 1997, near-surface water temperatures were lowest close to shore and isotherms generally paralleled the coast (Figure 5.2.1 a). Offshore termini of transects were ~3°C warmer than nearshore waters. Near-surface water temperatures in May 1998 were a few degrees warmer than in November 1997 and exhibited a more complex regional pattern (Figure 5.2.1 b). A pocket of colder water was observed along lines 6 and 7 in the mid-shelf area and nearshore along lines 4 and 5. In July-August 1998, near-surface waters throughout the region were warmer by several degrees (~30°C); few regional anomalies were observed (Figure 5.2.1 c). Slightly (0.5 to 1°C) warmer water was observed at the shoreward ends of lines 9 and 10 in May 1998. By November 1998, regional patterns in near-surface water temperatures exhibited the previous year's onshore/offshore gradients (Figure 5.2.1 d). Within the study area, near-surface waters were ~2°C warmer in November 1998 than in November 1997. The mean, standard deviation, and range of temperature for each cruise is given in Table 5.2.1. These values included temperatures from only the CTD at the times of the bottle trips.

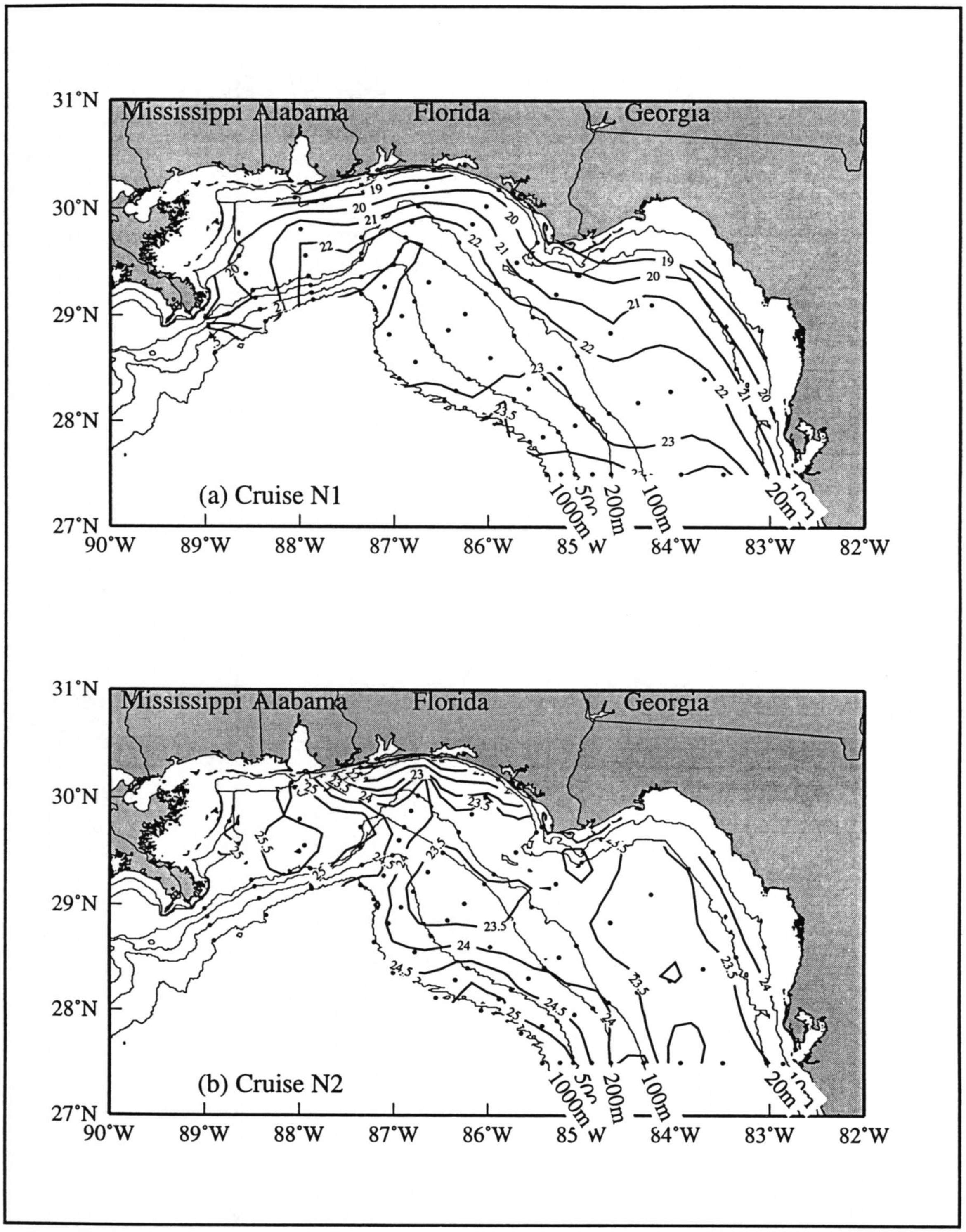
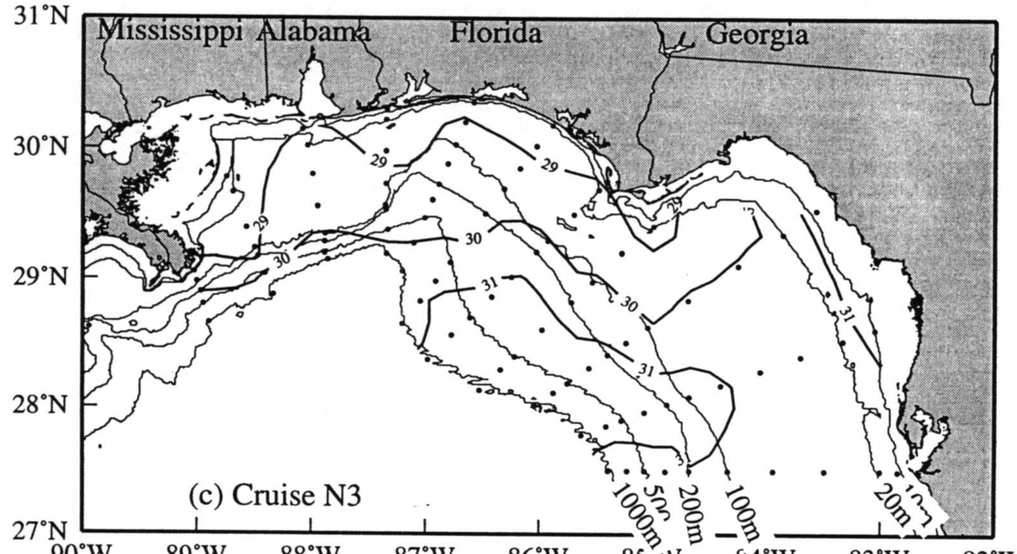


Figure 5.2.1. Potential temperature (°C) at 3.5 m on NEGOM hydrographic cruises. Shown are (a) N1, 16-26 November 1997, and (b) N2, 5-16 May 1998.



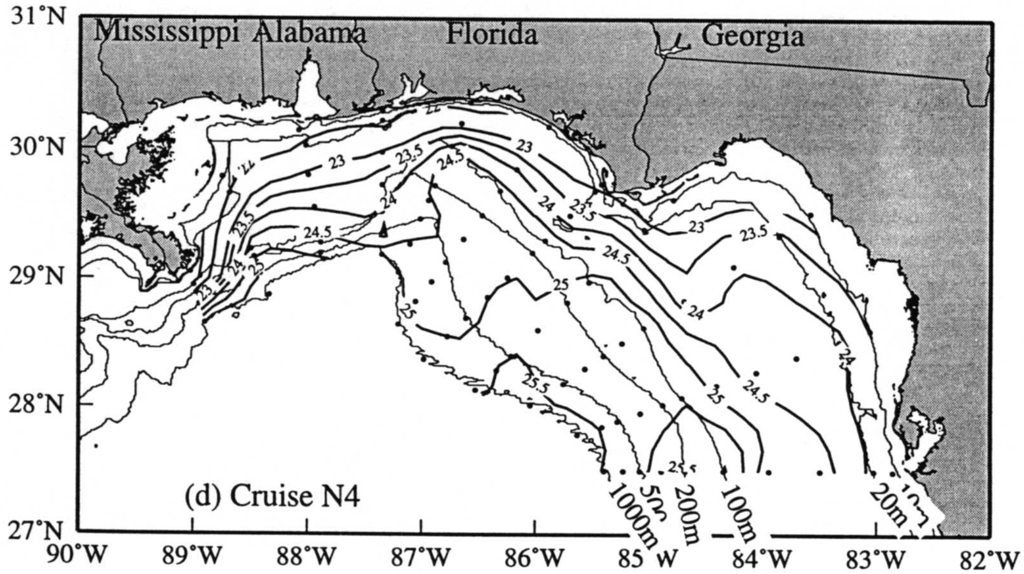


Figure 5.2.1. Potential temperature (°C) at 3.5 m on NEGOM hydrographic cruises. Shown are (c) N3, 26 July-6 August 1998 and (d) N4, 13-24 November 1998. (continued)

Table 5.2.1. Summary of water column temperature, salinity, and dissolved oxygen.

Variable	N =	Mean	Standard Deviation	Minimum	Maximum
Potential Temperature (°C)*					
All cruises	3423	19.22	5.67	4.71	32.01
N1	798	18.09	5.05	4.75	24.30
N2	865	18.78	4.77	4.71	26.29
N3	867	20.30	6.87	4.88	32.01
N4	893	19.61	5.47	4.89	26.09
Bottle Salinity					
All cruises	1303	35.51	1.35	20.03	36.67
N1	782	35.75	0.72	30.47	36.55
N2	179	35.15	2.04	22.34	36.67
N3	175	35.02	1.96	25.16	36.57
N4	167	35.29	1.76	20.03	36.67
Dissolved Oxygen ($mL \cdot L^{-1}$)					
All cruises	3414	3.99	0.93	1.90	8.93
N1	782	4.16	1.07	2.70	6.21
N2	854	4.09	0.99	2.12	8.93
N3	878	3.82	0.83	1.90	5.25
N4	900	3.91	0.81	2.57	5.24

* CTD values at bottle trips only

As expected, near-surface and near-bottom water temperatures in shallow water areas were similar with stratification increasing with increasing water depth. Across the shelf (> ~20 m), stratification intensifies as the surface waters warm through the spring and into the summer months. Stratification is modified by local mixing events. Over the four sampling periods, the near-bottom water temperature in water depths below 100 m remained relatively constant with near-bottom water temperatures at 200 m ~12 to 14°C, at 500 m ~8 to 10°C, and at 1000 m ~5°C (Figure 5.2.2). In waters with bottom depths >200 m, isotherms generally follow bathymetry. At 100 m water depth, there was a gradual increase in near-bottom water temperatures of a degree or two from the first to the last sampling. In November 1997, a slightly warmer tongue of near-bottom water was observed in the southeastern part of the study area south of Tampa, FL, in the mid-shelf region.

5.2.2 Salinity

Salinity varied across the study area (Table 5.2.1), especially near river discharge points (e.g., see region near line 1 in Figure 5.2.3). Near surface water salinities increased slightly in the off-shore direction during both November sampling periods by 1 to 1.5 (Figures 5.2.3 a and d). As with temperature, the near-shore isohaline contours parallel the coast line. The most obvious

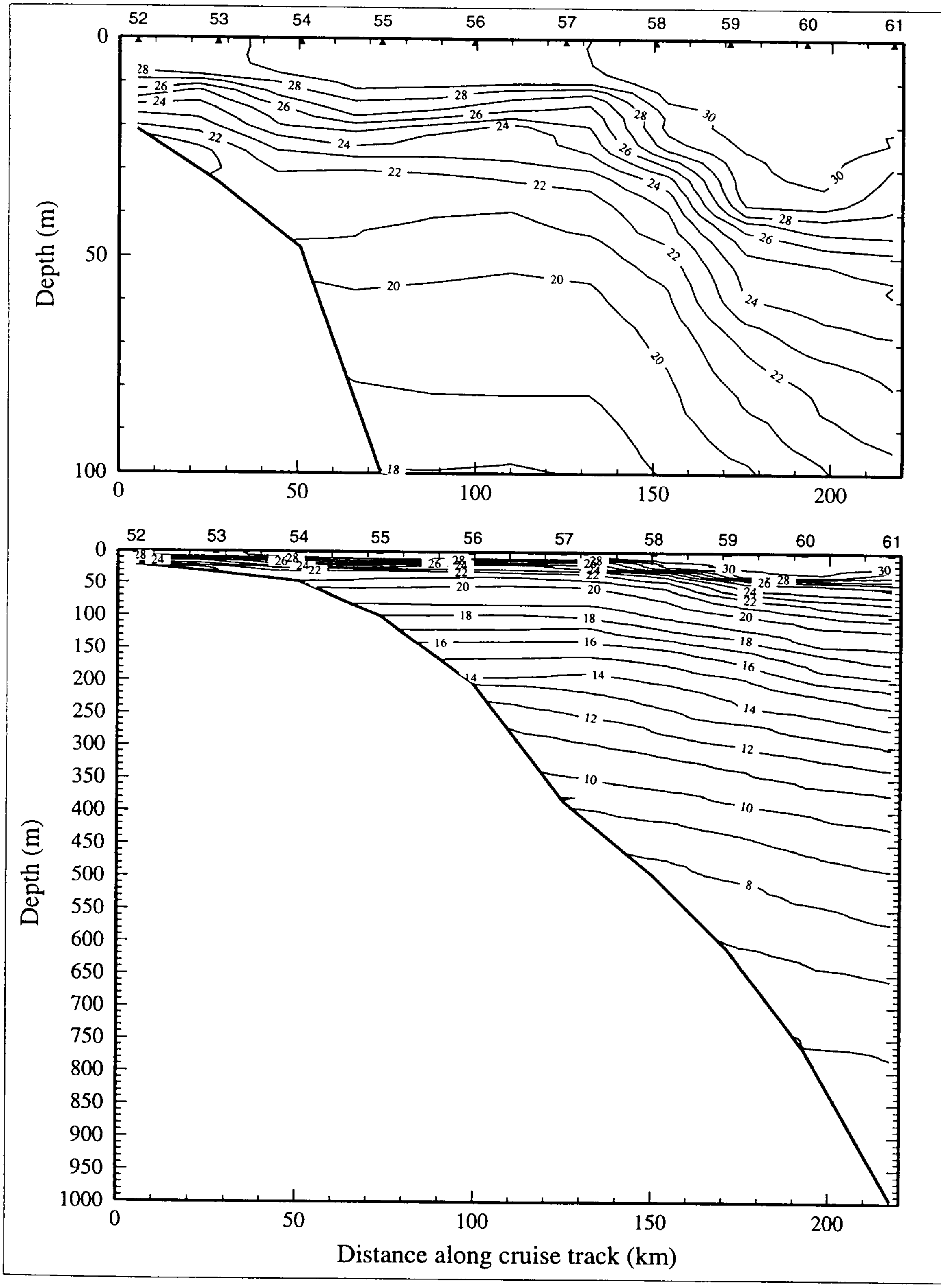


Figure 5.2.2. Potential temperature (°C) on line 6 of cruise N3, 26 July - 6 August 1998.

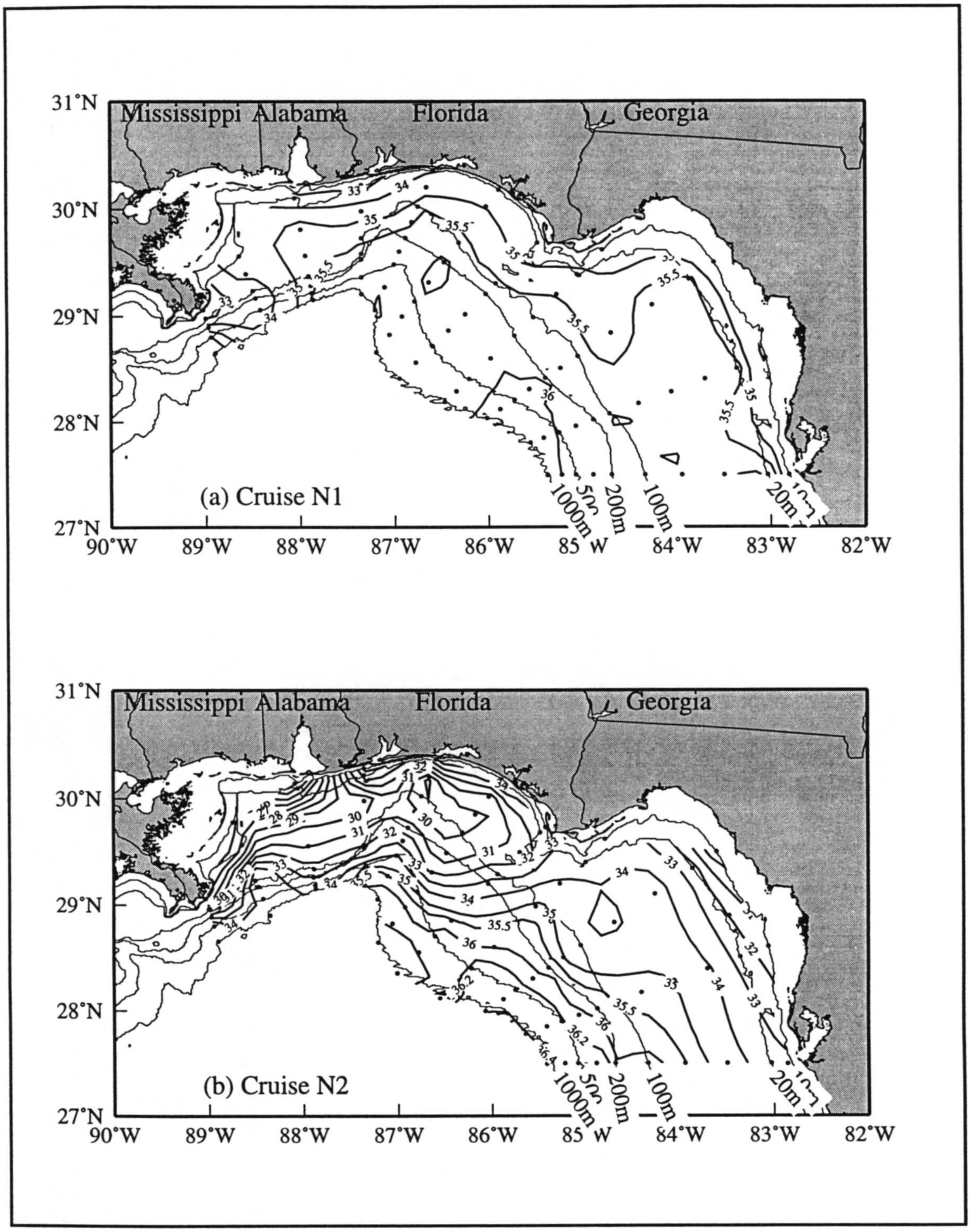


Figure 5.2.3. Salinity, from CTD data, at 3.5 m on NEGOM hydrographic cruises. Shown are (a) N1, 16-26 November 1997, and (b) N2, 5-16 May 1998.

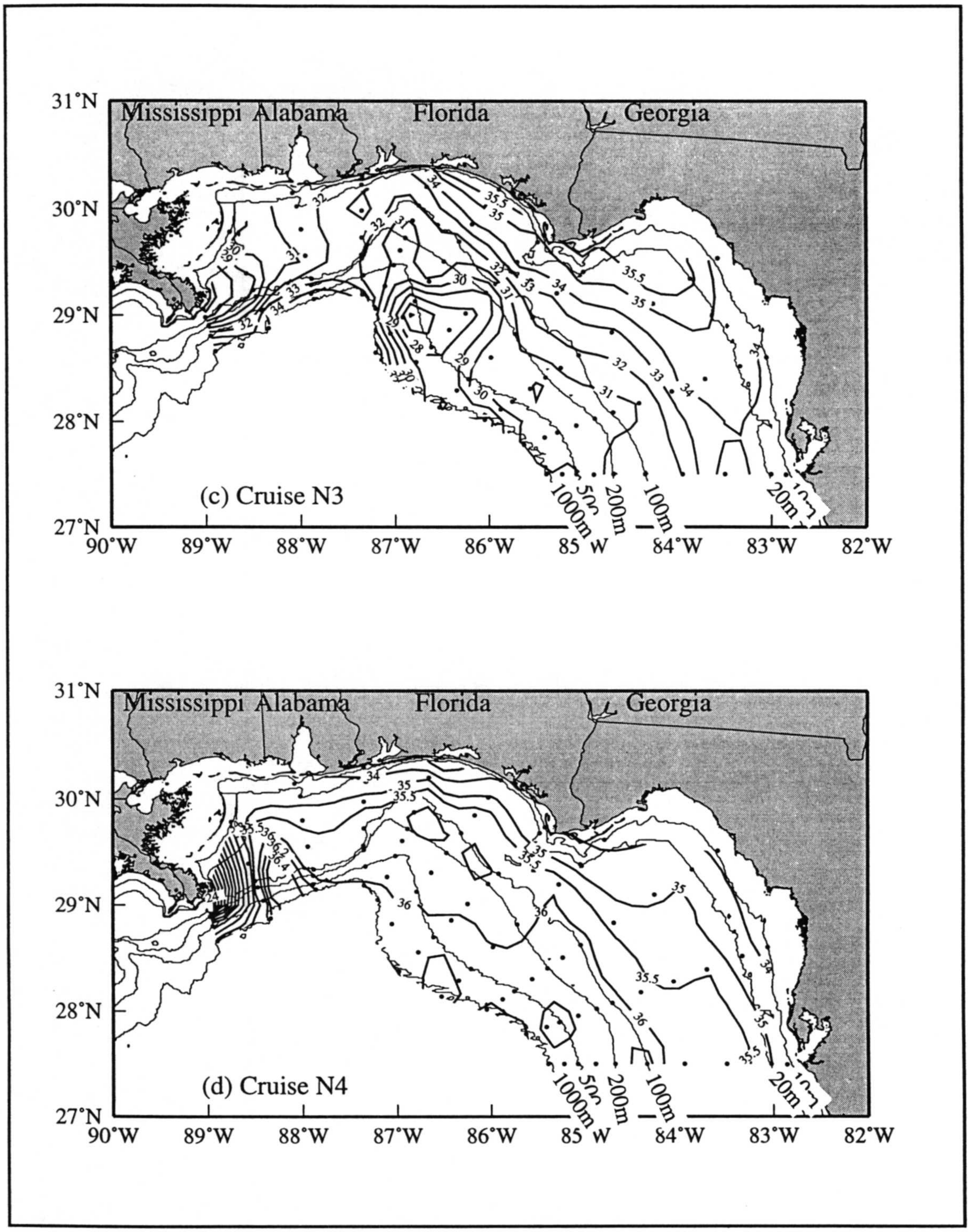


Figure 5.2.3. Salinity, from CTD data, at 3.5 m on NEGOM hydrographic cruises. Shown are (c) N3, 26 July-6 August 1998 and (d) N4, 13-24 November 1998. (continued)

features are the lenses of fresh water emanating from the rivers. For the current sampling period, this was most dramatic in May and November 1998 when salinities lower than 21 were observed near the mouth of the Mississippi River. Away from the river, near-surface water salinity distributions were relatively uniform during the November sampling periods. During the spring and summer sampling periods, near-surface water salinity patterns in the area were more complex. In May 1998, a pocket of lower salinity near-surface water was observed mid-shelf along lines 5 and 6 (Figure 5.2.3 b). This is offset to the northwest from a pocket of cooler water observed at the same time. Salinities were also lower offshore of Mobile Bay due to the outflow of fresh water from the bay into near-surface shelf waters. In the July-August sampling period, a lower salinity pocket of near-surface water was observed above the 500 m isobath along lines 6 and 7 (Figure 5.2.3 c). No corresponding temperature anomaly was detected. Near-bottom water salinities were relatively constant for all four samplings with salinities varying by only 1 to 1.5 within the study area. In the southeastern portion of the study area on the midshelf, near-bottom water salinities consistently show a maximum at ~100 m of water depth along lines 9 and 10. Most low salinity anomalies are restricted to a thin veneer of surface water due to density stratification (Figure 5.2.4). During the sampling period the lens of freshwater, when present, was restricted to the top 30 to 50 m and often to the top 10 m of the water column. The extent of vertical mixing depends on the timing of the fresh water intrusion, when sampling occurred, and mixing processes in the area. During periods of riverine inflow, the freshwater plume in near-surface waters was diminished although detectable along line 2.

5.2.3 Dissolved Oxygen

Dissolved oxygen concentrations in seawater are a balance between oxygen production during photosynthesis, equilibration across the seawater/atmosphere interface, and consumption during aerobic degradation/remineralization of organic matter. Equilibration is only important in surface waters that interact with the overlying atmosphere. Oxygen production by phytoplankton only occurs in the photic zone where ambient light intensities are high enough and of the right spectral quality to support photosynthesis. Aerobic consumption of oxygen occurs throughout the water column and in sediments where labile organic matter and a viable bacterial community can exist.

During most of the sampling period at most locations, the maximum, near-surface dissolved oxygen concentrations are near or above the atmospheric equilibrium value of ~5.5 $mL\cdot L^{-1}$ (Table 5.2.1). Gas solubility varies as a function of temperature and salinity. On occasion, elevated near-surface water dissolved oxygen concentrations were observed due to the local production of oxygen by photosynthesis. Near-bottom water dissolved oxygen concentrations decrease with increasing distance from shore and increasing bottom water depth. Near-bottom dissolved oxygen concentrations in shallow near-shore waters are close to the equilibrium values and decrease to less than 3.0 $mL\cdot L^{-1}$ in offshore regions. Near-bottom dissolved oxygen values are nearly uniform (~3 to 3.5 $mL\cdot L^{-1}$) in water depths greater than 100 m (e.g., see Figure 5.2.5). During the sampling period, a low bottom-water oxygen feature was observed between 200- and

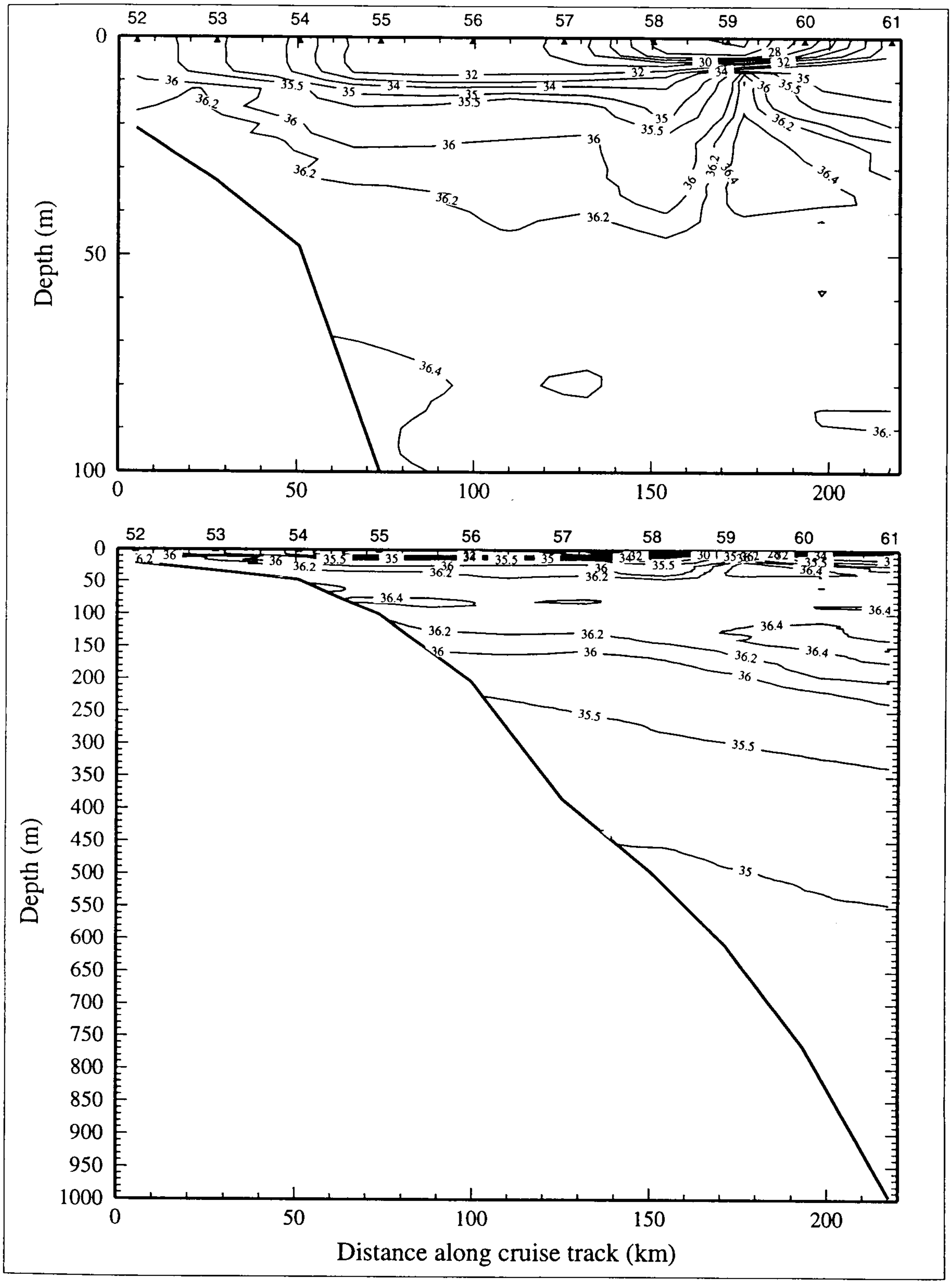


Figure 5.2.4. Salinity, from CTD data, on line 6 of cruise N3, 26 July-6 August 1998.

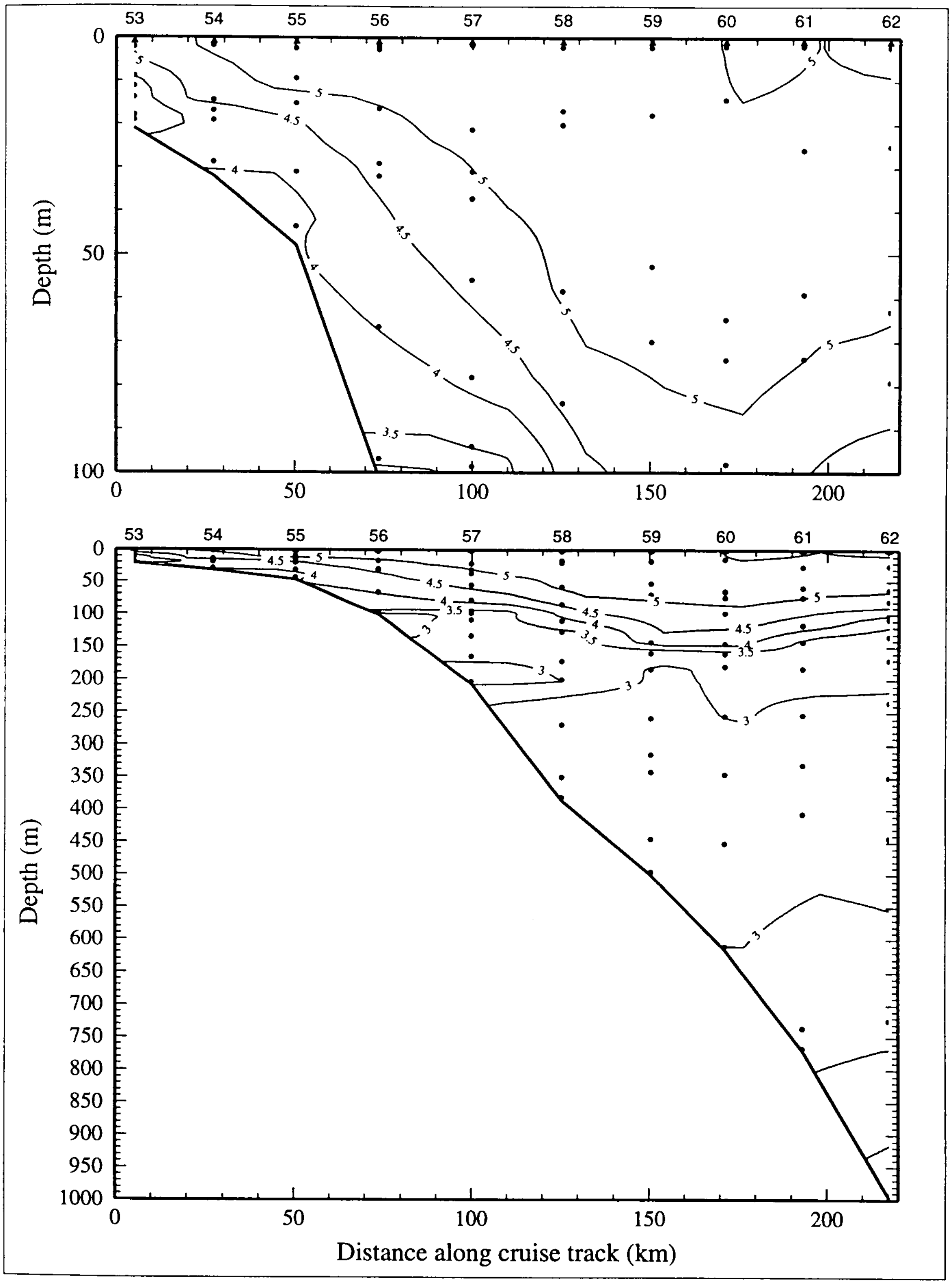


Figure 5.2.5. Dissolved oxygen (mL·L^{-1}) on line 6 of cruise N2, 5-16 May 1998. Dots denote bottle locations.

500-m water depth along lines 5, 6, 7, and 8. In the spring and summer, near-shore bottom oxygen levels become depleted over those observed during the fall and winter sampling period. These depletions are most likely due to the consumption of oxygen during aerobic degradation of sedimentary organic matter. Seasonal variations at shallow water sites coincide with increased exposure of the sea bottom to sunlight. Decreases in dissolved oxygen in the water column below the photic zone are the result of consumption of oxygen during aerobic degradation of particles settling through the water column. Near-bottom dissolved oxygen values can be decreased further by aerobic degradation of sedimentary organic matter.

5.2.4 Nutrients

Nutrient concentrations and distributions in the study area are controlled by a combination of biogeochemical and physical processes. Processes effecting nutrient concentrations are river discharges, coastal currents and winds, upwelling, biological activity, and rainfall. In near-bottom waters, remineralization of organic matter can lead to elevated levels of nutrients as well. Elevated nutrient levels can support plankton blooms. Nutrient-rich waters often occur in the offshore plumes of the river systems in the area. The interaction of sources and sinks produces seasonal and geographic variations in nutrient distributions. The nutrient component describes spatial, seasonal, and interannual variations in these distributions and examines nutrient distributions in the context of water column stability, river discharge, wind fields, and circulation patterns.

Nitrite and urea concentrations were low across the study area and throughout the water column during the sampling period (Table 5.2.2). The concentrations measured were uniform and generally below 0.10 μM with most values below 0.05 μM. On average, ammonia mean concentrations were similar (~0.11 μM) for all cruises and varied from 0.0 to 4.48 μM. In contrast, the major phytoplankton nutrients (nitrate, phosphate, and silicate) showed significant variations with location, water depth, and time of year.

Nitrate: Near-surface nitrate concentrations were low (~0.1 μM) across the study area during the November 1997 sampling. However, in May 1998, near-surface waters exhibited elevated nitrate concentrations (>10 μM) along lines 1 and 2 (Figure 5.2.6). In August, near-surface water nitrate concentrations were low (~0.1 μM), with a few exceptions close to the mouths of rivers. In November 1998, nitrate concentrations were again elevated in close proximity to the mouth of the Mississippi, but low east of line 2. Near-bottom water nitrate levels gradually increased with distance offshore and showed similar distributions throughout the sampling period. In general, nitrate concentrations were low throughout the upper 40 to 90 meters of the water column, depending on location and time of year. The deepest nitraclines occurred in November when the upper water column was well mixed. Below the nitracline, nitrate concentrations rapidly increased with water depth to a maximum of 28 to 30 μM to approximately 500 m with relatively constant concentrations in deeper waters (e.g., Figure 5.2.6).

Table 5.2.2. Summary of water column dissolved nutrients.

Variable	N =	Mean	Standard Deviation	Minimum	Maximum
Nitrate (μM)					
All cruises	3423	8.61	9.94	0.00	32.88
N1	794	9.41	10.25	0.00	32.12
N2	1850	8.13	9.55	0.00	32.02
N3	878	8.87	10.07	0.01	30.95
N4	901	8.10	9.88	0.00	32.88
Nitrite (μM)					
All cruises	3423	0.08	0.17	0.00	2.55
N1	794	0.05	0.07	0.00	0.58
N2	850	0.11	0.23	0.00	2.03
N3	878	0.09	0.21	0.00	2.55
N4	901	0.07	0.14	0.00	1.35
Ammonia (μM)					
All cruises	3423	0.11	0.19	0.00	4.48
N1	794	0.11	0.16	0.00	2.47
N2	850	0.11	0.18	0.00	1.71
N3	878	0.14	0.26	0.00	4.48
N4	901	0.08	0.15	0.00	2.52
Urea (μM)					
All cruises	3398	0.17	0.18	0.00	2.31
N1	769	0.10	0.13	0.00	1.56
N2	850	0.28	0.24	0.00	1.61
N3	878	0.17	0.13	0.00	1.66
N4	901	0.14	0.16	0.00	2.31
Phosphate (μM)					
All cruises	3423	0.51	0.58	0.00	2.03
N1	794	0.58	0.60	0.00	2.03
N2	850	0.46	0.55	0.00	1.89
N3	878	0.53	0.58	0.00	1.91
N4	901	0.46	0.57	0.00	1.91
Silicate (μM)					
All cruises	3423	5.83	6.23	0.02	47.84
N1	794	5.57	6.21	0.03	26.27
N2	850	6.13	6.18	0.02	28.42
N3	878	6.53	6.16	0.03	36.30
N4	901	5.13	6.28	0.02	47.84

Phosphate: Near-surface phosphate concentration distributions were similar to those of nitrate. However, elevations in phosphate concentrations near rivers were less dramatic than for nitrate. Near-surface concentrations were low and uniform (Table 5.2.2). Greatest elevations in phosphate concentrations were near the mouth of the Mississippi in November 1998 (contrast the distributions on lines 1 and 6 on cruise N4 in Figures 5.2.7 and 5.2.8). While near-bottom phosphate values increased with increasing water depth, the increase was much less dramatic

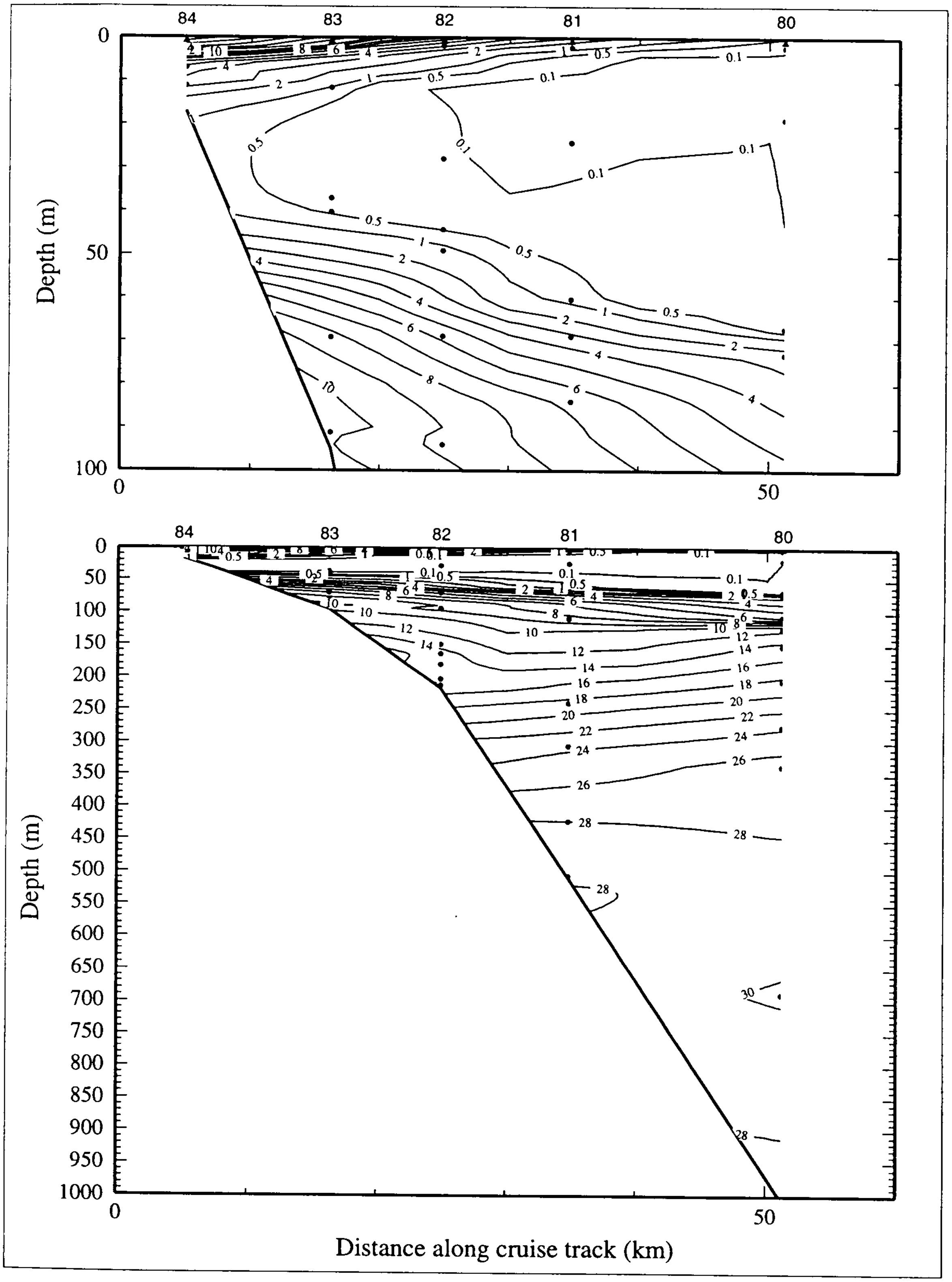


Figure 5.2.6. Nitrate (µM) on line 1 of cruise N2, 5-16 May 1998. Dots denote bottle locations.

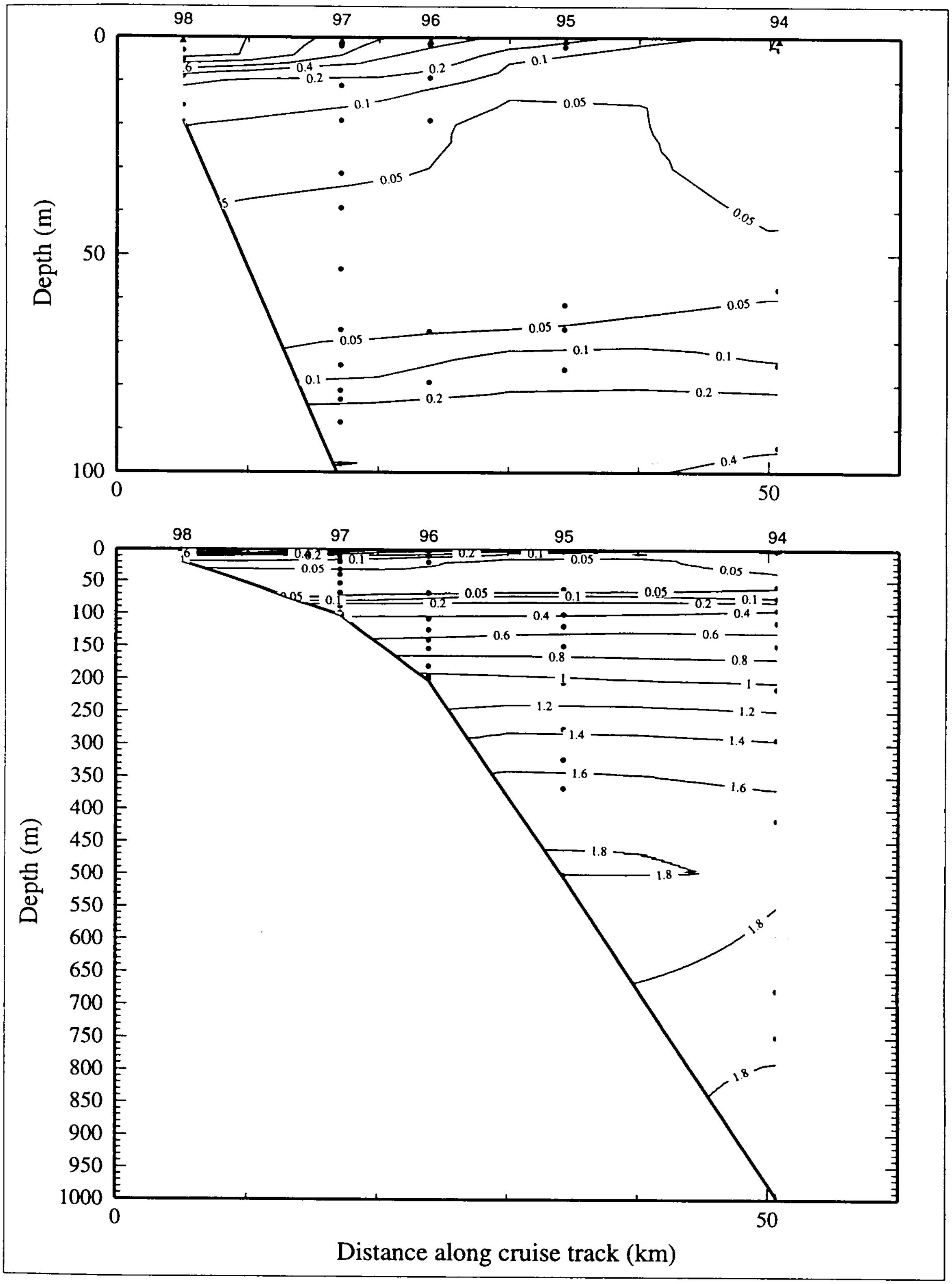


Figure 5.2.7. Phosphate (μM) on line 1 of cruise N4, 13-24 November 1998. Dots denote bottle locations.

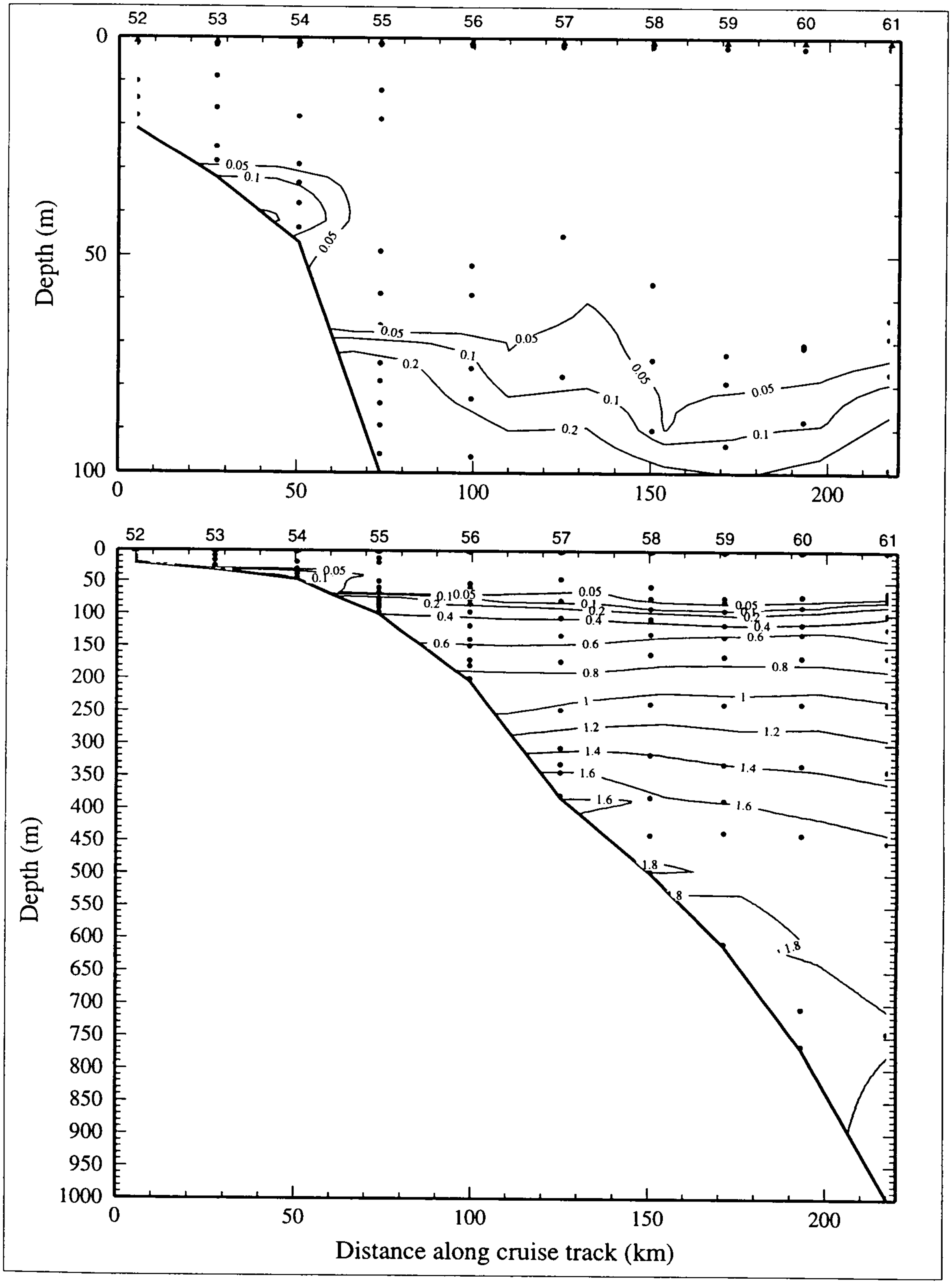


Figure 5.2.8. Phosphate (µM) on line 6 of cruise N4, 13-24 November 1998. Dots denote bottle locations.

than for nitrate. Near-bottom water phosphate concentrations were near zero in near-shore waters, increased to 0.8 to 1.2 μM at 200 m, 1.6 to 1.8 μM at 500 m, and >1.6 μM at 1000 m water depth (Figures 5.2.7 and 5.2.8).

Silicate: Near-surface water silicate concentrations were often elevated near the Mississippi River and along the Mississippi/Alabama coast (Table 5.2.2; Figure 5.2.9). While near-surface water silicate concentrations were relatively uniform in November 1997, by May 1998 a shelf-wide elevation in silicate concentrations was evident from Mississippi to northern Florida extending seaward to the 100-m isobath. In July-August similar regional elevations were apparent at the mouth of the Mississippi River and offshore of Pensacola, FL. A pocket of silicate-rich surface water was also observed along lines 6 and 7 in August corresponding to the pocket of cooler water previously described. In November 1998, highs in coastal water silicate concentrations were less dramatic but a plume of silicate-rich water was observed seaward of the mouth of the Mississippi River. As with other nutrients, near-bottom water silicate levels paralleled bathymetry. Near-bottom silicate concentrations were ~4 to 6 μM at 100 m, ~20 μM at 500 m, and 25 μM at 1000 m water depth (Figure 5.2.9). Silicate concentrations were low in the upper 40 to 100 m of the water column except where freshwater influxes caused elevated concentrations. At some locations, it also appeared that silicate was diffusing from the sediments creating localized, near-bottom anomalies in silicate concentrations.

5.2.5 Particulate Matter Distributions

Particulate matter in the world oceans is derived from a variety of sources including river discharges, living phytoplankton and bacteria, atmospheric deposition, and detrital remains of organisms. Particulate matter is organic and inorganic and can contain living biological organisms. The living portion of particulate matter interacts with water column chemistry through the uptake of nutrients to form biomass, production of oxygen during photosynthesis, and chemical reactions related to the excretion of waste products and decay of organic detritus. Water column chemistry and particulate matter concentrations and distributions are the end result of these interactions.

Particulate distributions can be described in terms of particulate matter, particulate organic carbon, particulate organic nitrogen, planktonic pigments, and light transmission. A summary of particulate properties observed in the study area is given in Table 5.2.3. Vertically continuous estimates of particulate concentrations were provided by transmissometry. Transmissometry records the horizontal and vertical distribution of particles and was used to assess temporal (seasonal and interannual) variability in particle distributions. In the open ocean, most particles are biological organisms and associated detritus. However in near-shore regions, riverine sources of inorganic materials and terrestrial organic matter can be important. Particulate matter concentrations, distributions, and temporal variations are evaluated in the context of water column stability, river discharge, wind fields, and circulation patterns.

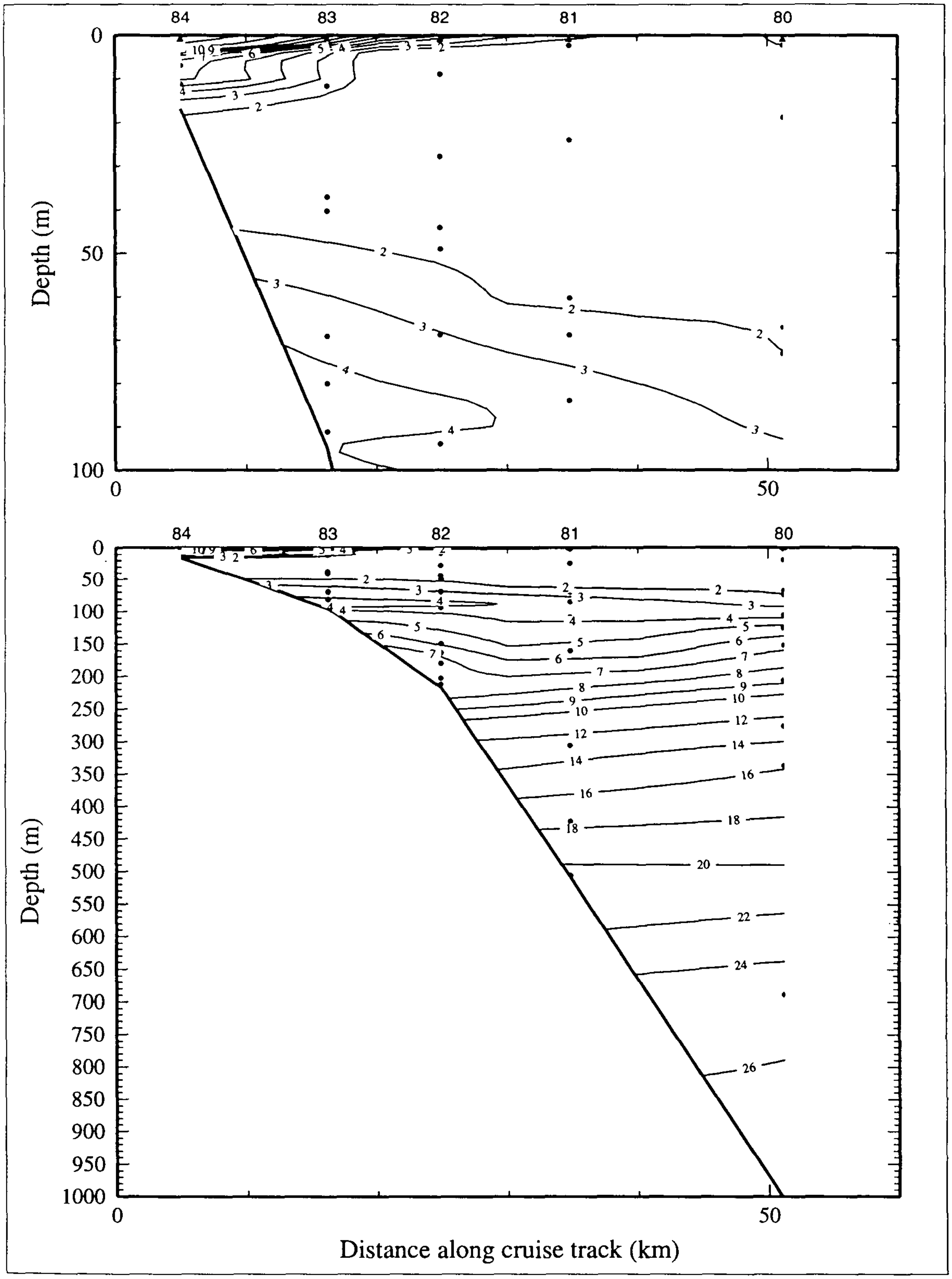


Figure 5.2.9. Silicate (μM) on line 1 of cruise N2, 5-16 May 1998. Dots denote bottle locations.

Table 5.2.3. Summary of water column particulate properties.

Variable	N =	Mean	Standard Deviation	Minimum	Maximum
Transmittance (%)					
All cruises	3475	85.6	7.1	3.5	92.7
N1	798	86.5	53	7.6	89.4
N2	876	85.2	6.6	24.4	88.9
N3	884	85.2	6.2	27.	88.9
N4	917	85.5	9.2	3.5	92.7
Particulate Matter ($\mu g \cdot L^{-1}$)					
All cruises	725	467.2	922.6	18.1	10,368
N1	180	335.0	612.7	18.5	4,967
N2	186	402.3	723.0	18.1	6,418
N3	181	552.6	926.7	22.5	9,200
N4	178	581.8	1280.5	34.7	10,368
Particulate Organic Carbon ($\mu g \cdot L^{-1}$)					
All cruises	476	73.2	89.2	3.7	730.3
N1	118	68.0	51.9	9.4	235.5
N2	120	62.7	84.8	6.1	666.9
N3	118	115.4	126.1	7.0	730.3
N4	120	47.3	61.4	3.7	403.6
Particulate Organic Nitrogen ($\mu g \cdot L^{-1}$)					
All cruises	476	13.0	16.0	0.5	144.0
N1	118	11.7	8.9	1.6	39.5
N2	120	11.1	14.2	1.4	108.5
N3	118	20.8	23.3	1.3	144.0
N4	120	8.7	11.2	0.5	78.1

Light Transmission: Light transmission was lowest in areas of riverine inputs of particulate matter (e.g., Figure 5.2.10 shows values on line 1, with its influence from the Mississippi River, from cruise N2). Ninety (90) percent or greater of light is transmitted at most locations throughout the study area with little or no vertical structure evident. Nepheloid layers were observed along lines 1 and 2, and to a lesser extent line 3, indicating outflow of particulate laden water from the Mississippi River during all four cruises. The shallowest stations along lines 7, 8, 10, and 11 exhibited reduced transmission as well due to outflow of particulate-laden water from the Apalachicola and Suwannee Rivers. Particulate matter concentrations and beam c values were well correlated.

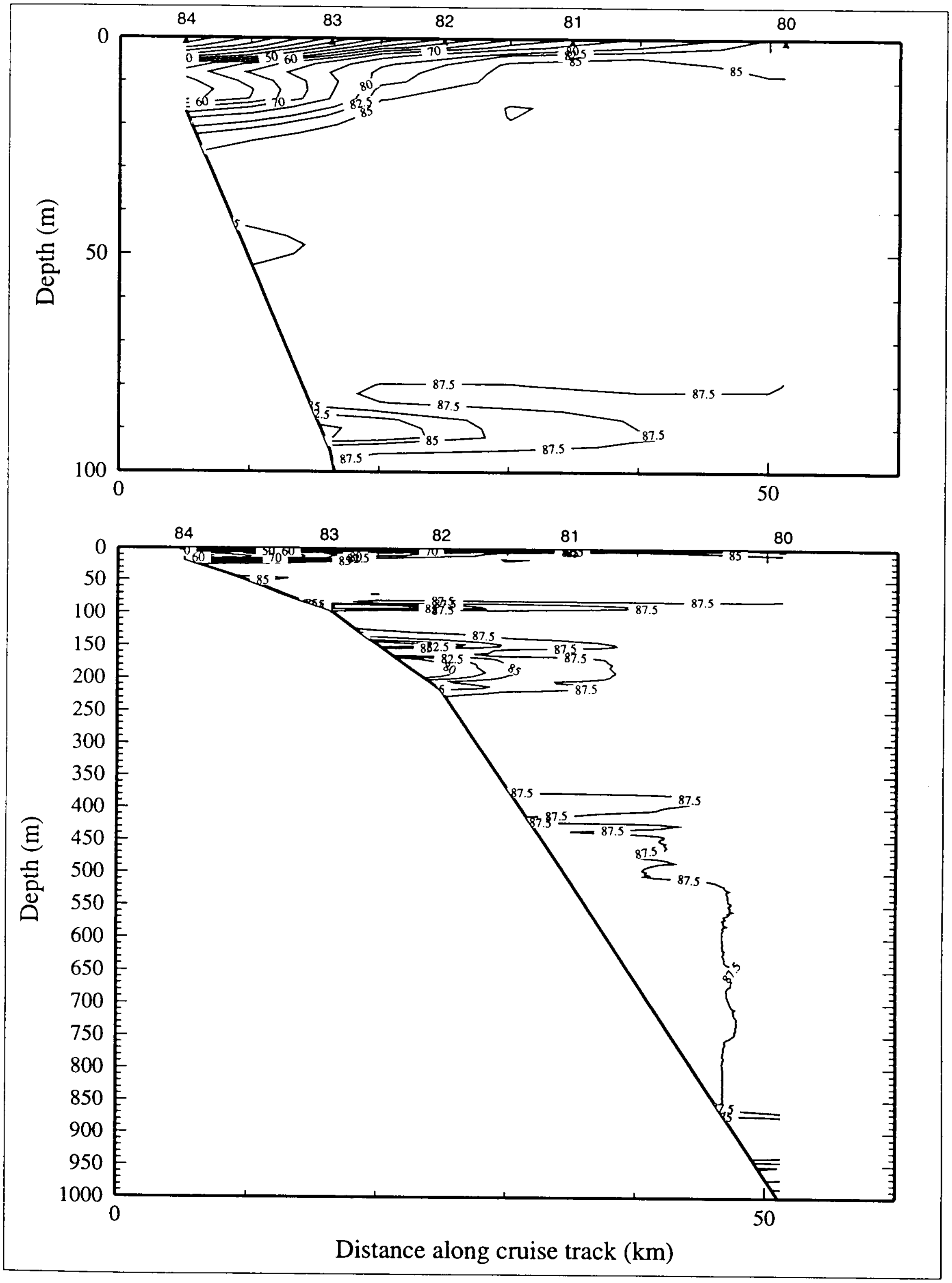


Figure 5.2.10. Light transmission (%; 660 nm wave length; 25-cm path length) on line 1 of cruise N2, 5-16 May 1998.

Particulate Matter: Discrete samples for determination of particulate matter (PM) concentrations were taken in near-surface and near-bottom waters. The amount and distribution of PM in the study area differed depending on the sampling period. During November 1997, near-surface water PM concentrations were highest near the mouth of the Mississippi River (lines 1 and 2), and offshore of Apalachicola (lines 7 and 8; Figure 5.2.11 a). Near-surface water PM was elevated across the Mississippi/Alabama shelf and extending out to the 500 m isobath. Near-surface water PM concentrations near the Mississippi River where nearly twice as high as offshore Apalachicola. The plume of PM laden near-surface water offshore of Apalachicola extended over the relatively shallow shelf area to bottom water depths of 100 m. Away from riverine inputs, near-surface water PM concentrations were generally less than 200 $\mu g \cdot L^{-1}$. In May, near-surface water PM concentrations were elevated across a wide expanse of the shelf-area within the study area (Figure 5.2.10 b). Near-surface water PM observed offshore of the Mississippi River were quite high (>200 $\mu g \cdot L^{-1}$) and the PM laden water was broadly distributed across the Mississippi Bight region. During July-August, near-surface water PM distributions exhibited more complex patterns (Figure 5.2.10 c). In November 1998, the riverine influences were again recognizable, but a secondary enhancement in PM was also apparent in the central shelf region of the area (Figure 5.2.11 d). During all samplings, near-surface concentrations tended to decrease with distance offshore.

Bottom water PM distributions generally mirrored the surface distributions but were at lower concentrations. Near-bottom water PM concentrations were elevated near rivers and across shelf areas that exhibited high near-surface water PM concentrations. For water depths greater than 200 m, bottom PM values were generally uniform and less than 300 $\mu g \cdot L^{-1}$. Bottom PM values continued to decrease to 100 $\mu g \cdot L^{-1}$ or less at water depths of 500 m or more. Near-bottom water PM-laden plumes were evident near the Mississippi River out to bottom water depths of 1000 m.

Particulate Organic Carbon: As mentioned above, particulate matter can be organic or inorganic in origin and living or dead. As a first indication of the origins of PM, particulate organic carbon (POC) content was measured in near-surface and near-bottom waters. Unlike PM, there is no detector that specifically determines POC content by *in situ* measurement. However, when the inorganic content of PM is low, transmission can be used to estimate POC. POC in near-surface waters accounted for 2.5 to 100% of the PM during the sampling period. In general, POC in near-surface waters accounted for 25 to 40% of the PM while in near-bottom water POC was only about 7 to 20% of the PM. This is indicative of phytoplankton productivity in the shallow water photic zone and remineralization of organic carbon in the water column. Near-bottom particulates also may have a contribution from resuspended, relatively organic carbon-poor sediments.

As for PM, regional patterns in POC differ greatly in time (compare Figures 5.2.12 a and b and Figures 5.2.12 a and d). In general, POC concentrations decrease with increasing distance from shore. POC in near-surface waters over areas with bottom depths less than 100 m generally exceeded 100 $\mu g \cdot L^{-1}$. In deep water, near-surface water POC concentrations were usually less

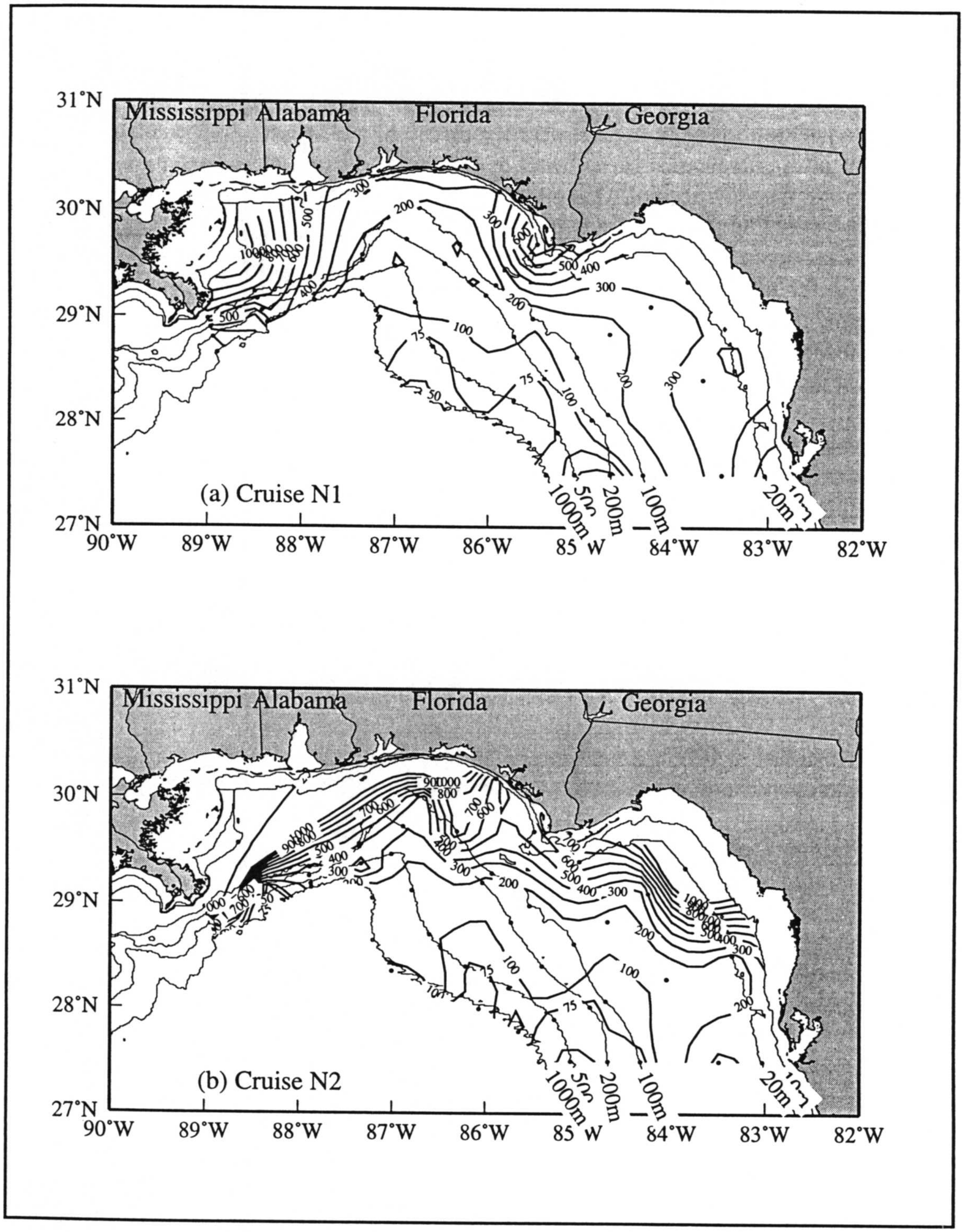


Figure 5.2.11. Particulate material ($\mu g \cdot L^{-1}$) at 3.5 m on NEGOM hydrographic cruises. Shown are (a) N1, 16-26 November 1997, and (b) N2, 5-16 May 1998.

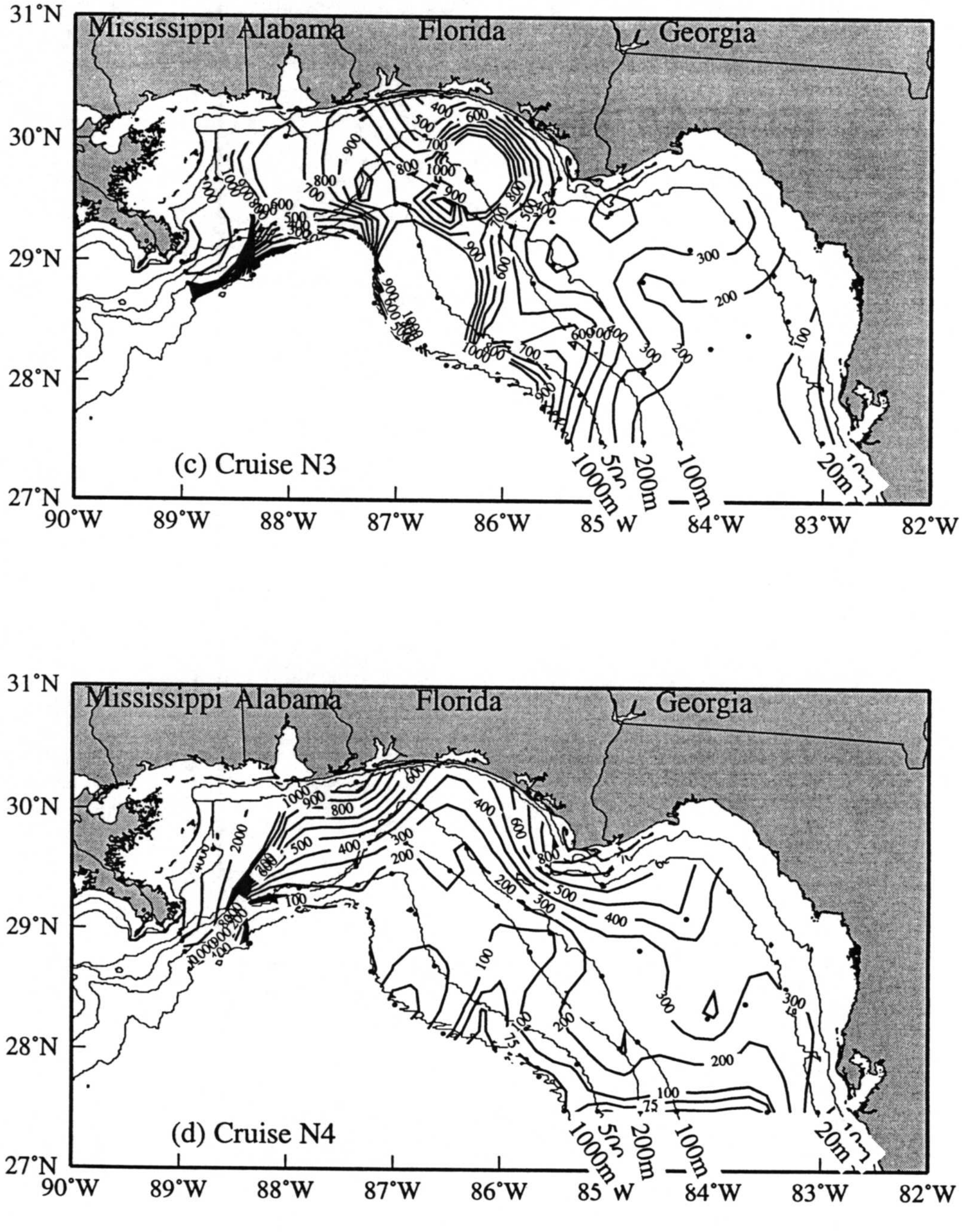


Figure 5.2.11. Particulate material ($\mu g \cdot L^{-1}$) at 3.5 m on NEGOM hydrographic cruises. Shown are cruises (c) N3, 26 July-6 August 1998 and (d) N4, 13-24 November 1998. (continued)

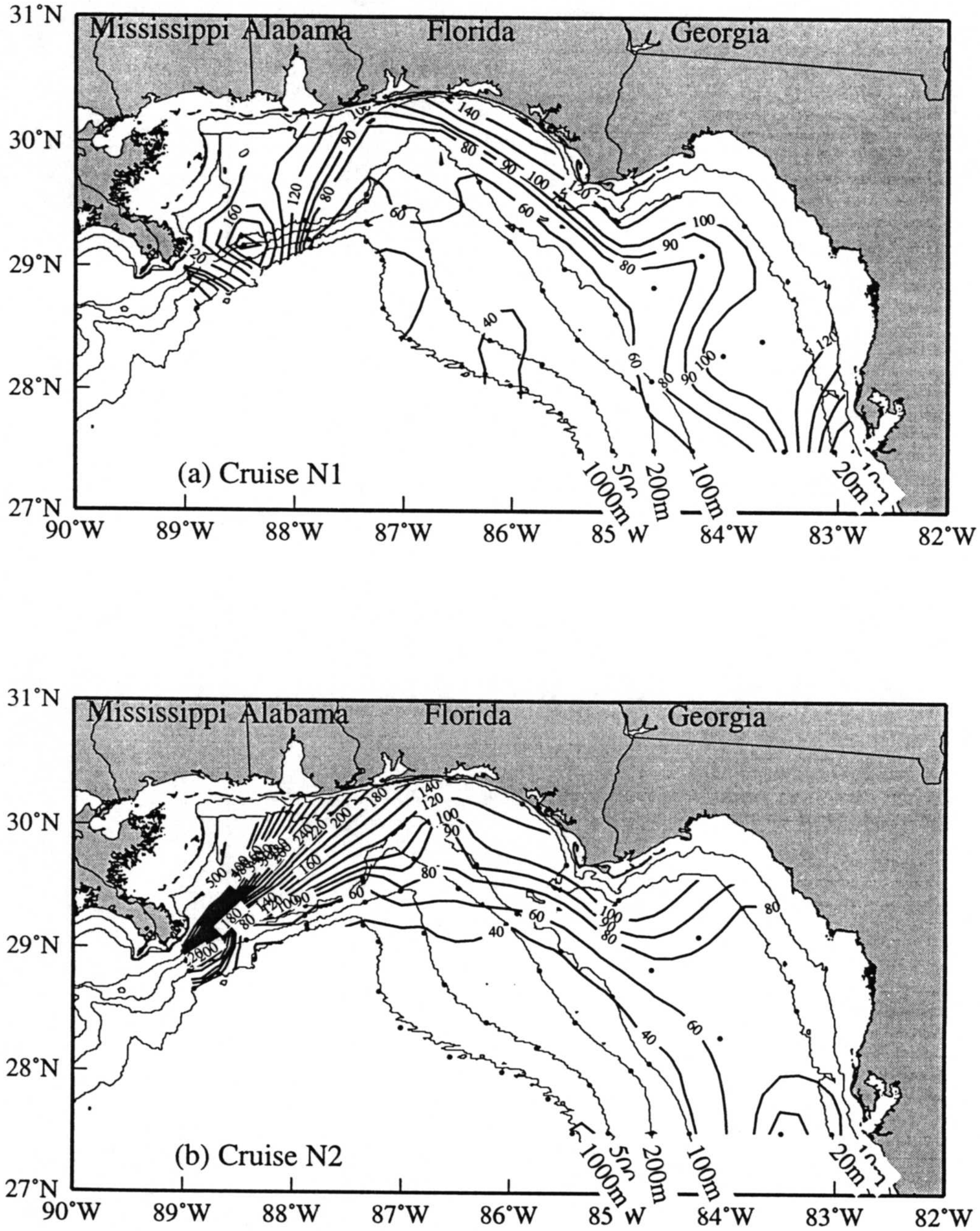


Figure 5.2.12. Particulate organic carbon ($\mu g \cdot L^{-1}$) at 3.5 m on NEGOM hydrographic cruises. Shown are cruises (a) N1, 16-26 November 1997, and (b) N2, 5-16 May 1998.

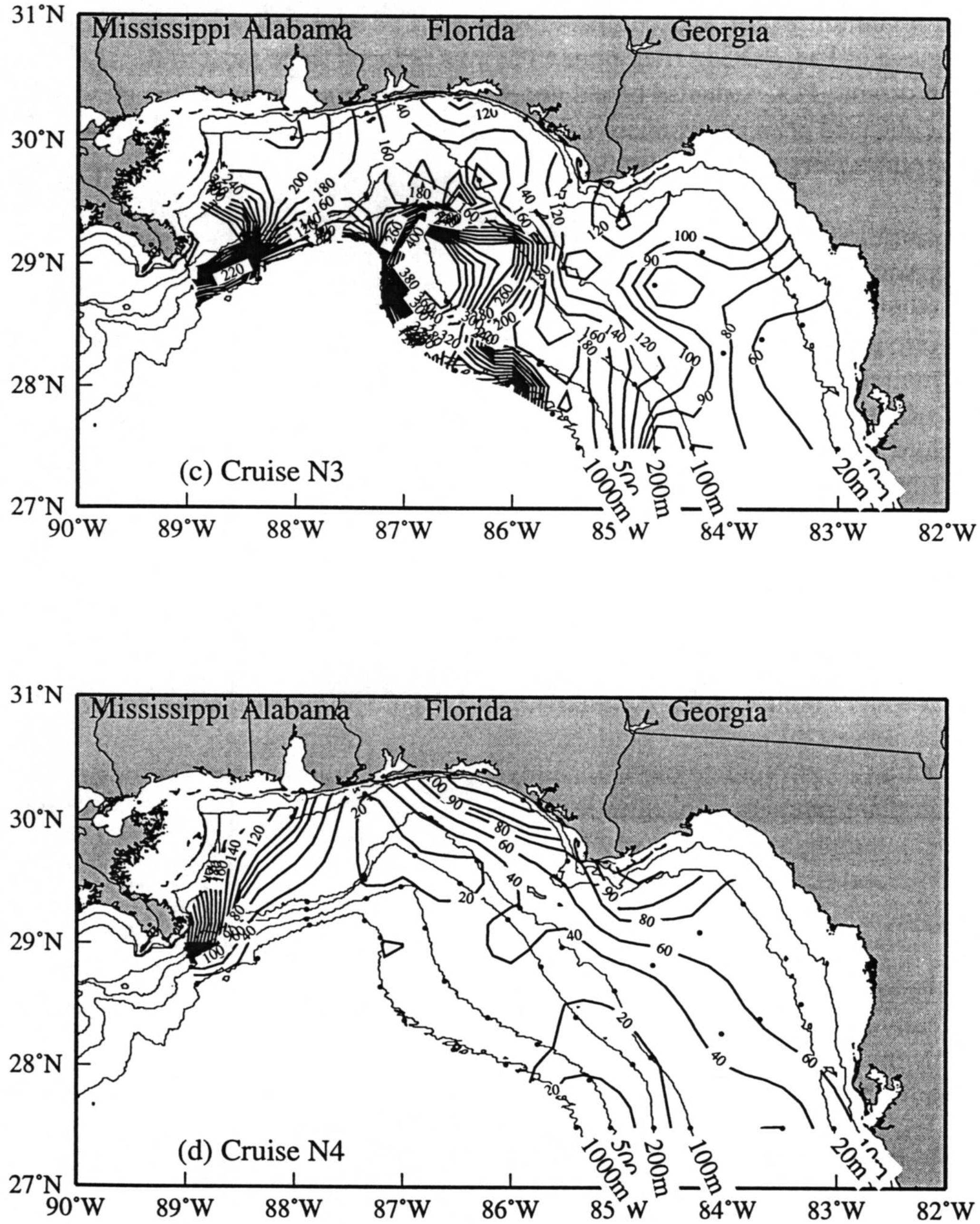


Figure 5.2.12. Particulate organic carbon ($\mu g \cdot L^{-1}$) at 3.5 m on NEGOM hydrographic cruises. Shown are cruises (c) N3, 26 July-6 August 1998 and (d) N4, 13-24 November 1998. (continued)

than 100 $\mu g \cdot L^{-1}$. The highest POC levels were associated with high PM plumes at river mouths. In many instances, high POC values were broadly distributed across the shelf–indicative of an *in situ* phytoplankton origin (e.g., compare Figure 5.2.12 c with Figure 5.2.13 c in Section 5.2.6). As a percentage of PM, POC in river plume PM was reduced since most of the riverine PM was inorganic in origin. POC can also be enhanced at in river plumes due to the elevated nutrients supporting enhanced primary productivity. However, a decrease in light availability in high PM waters can inhibit primary productivity as well.

POC concentrations in near-bottom waters generally paralleled POC distributions in the near-surface waters. Near-bottom water POC concentrations generally decreased with increasing distance offshore and increasing water depth. Near-bottom POC concentrations in deeper water (>100 m) were significantly less than those of near-surface water as a result of remineralization of organic matter during transport through the water column. In shallower water, near-bottom water POC often exceeded POC in near-surface waters probably due to the primary productivity maxima being below the near-surface water depth of collection. At some locations, resuspension of organic-rich sediments may be occurring.

5.2.6 Phytoplankton Pigments

Chlorophyll and carotenoid pigment distributions are used to infer spatial and temporal variations in phytoplankton biomass and taxonomic composition. Phytoplankton exert an important influence on water column properties. Phytoplankton are an important source of particulates, they produce oxygen during photosynthesis, and they fix water column nutrients into biomass. The composition of particulate pigments provides insight into the relative abundance of algal groups. The plant pigment concentrations and distributions are used to describe the spatial, seasonal, and interannual variations in phytoplankton communities; calibrate *in vivo* fluorescence measurements; and examine phytoplankton communities in the context of water column stability, river discharge, wind field, and circulation patterns.

Chlorophyll *a*: Chlorophyll *a* concentrations are an indication of how much particulate matter, and specifically POC, is living phytoplankton. As an estimate, phytoplankton biomass can be calculated by multiplying chlorophyll *a* concentrations by 250. However, many factors affect the chlorophyll *a* to cellular carbon ratio in phytoplankton, so this conversion is semi-quantitative at best. Chlorophyll *a* was measured in near-surface waters, at the water column fluorescence maxima as indicated by *in situ* fluorometry, and at the base of the photic zone. Discrete samples were also used to calibrate the *in situ* fluorometer to calculate chlorophyll *a* concentrations at locations where discrete samples were not taken. A summary is given in Table 5.2.4.

In general, near-surface chlorophyll *a* concentrations were similar to the maximum concentrations in vertical profiles (Table 5.2.4; Figure 5.2.13). In contrast to PM and POC distributions, chlorophyll *a* was relatively uniformly distributed across the shelf regions of the study area. Elevated chlorophyll *a* values were associated with discharges from the smaller

Table 5.2.4. Summary of water column particulate pigment concentrations.

Variable (ng·L^{-1})	N =	Mean	Standard Deviation	Minimum	Maximum
Chlorophyll *a*					
All cruises	672	402.3	731.4	0.0	12,229
N1	169	336.8	461.9	14.3	3,889
N2	177	484.7	716.0	0.0	4,175
N3	168	573.4	1137.9	40.3	12,229
N4	162	205.2	183.1	14.9	1,350
19-Butanoyloxyfucoxanthin					
All cruises	672	28.3	71.0	0.0	1,678
N1	169	25.9	24.6	0.0	164
N2	173	22.6	35.5	0.0	169
N3	168	24.1	30.5	0.0	13
N4	162	41.5	133.5	0.0	1,678
Fucoxanthin					
All cruises	672	59.2	146.0	0.0	1,872
N1	169	35.2	56.3	0.0	316
N2	173	85.0	206.3	0.0	1,336
N3	168	91.7	181.4	0.0	1,872
N4	162	62.6	64.0	0.0	350
19-hexanoyloxyfucoxanthin					
All cruises	672	82.5	69.0	0.0	627
N1	169	55.4	38.5	0.0	193
N2	173	94.6	76.6	0.0	388
N3	168	116.3	72.1	0.0	430
N4	162	62.6	64.0	0.0	627
Diatoxanthin					
All cruises	672	4.1	22.2	0.0	232
N1	169	1.2	7.4	0.0	79.7
N2	173	12.5	40.8	0.0	232
N3	168	2.1	10.0	0.0	73.8
N4	162	0.0	0.3	0.0	3.7
Zeaxanthin					
All cruises	672	56.2	235.2	0.0	5,328
N1	169	34.9	31.3	0.0	141
N2	173	60.1	116.3	0.0	1,092
N3	168	126.1	446.4	0.0	5,328
N4	162	1.8	5.6	0.0	44.8
Chlorophyll *b*					
All cruises	672	86.5	109.0	0.0	745
N1	169	70.6	65.2	0.0	289
N2	173	74.3	107.6	0.0	606
N3	168	142.4	142.6	0.0	745
N4	162	58.2	84.3	0.0	484

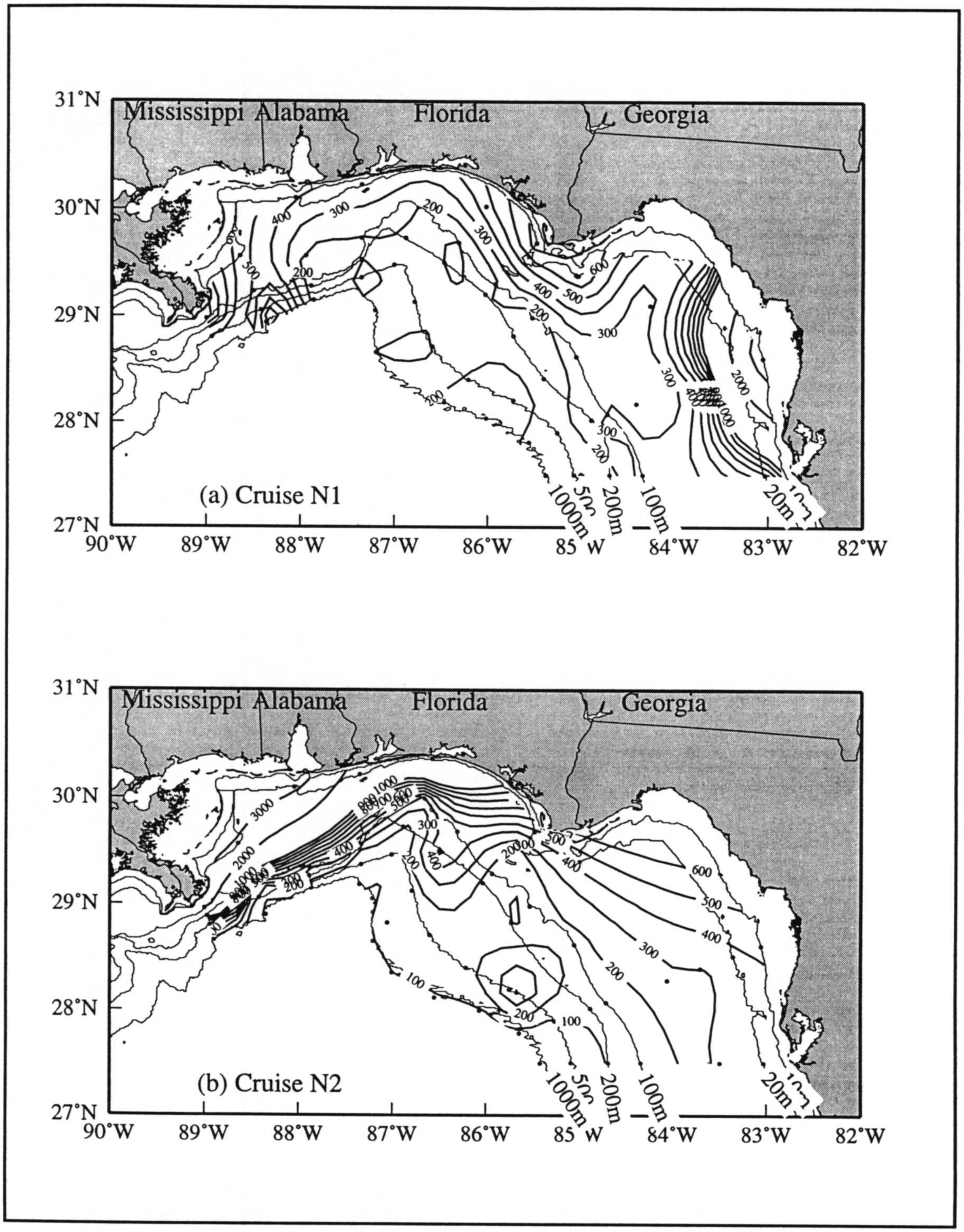


Figure 5.2.13. Chlorophyll *a* (ng·L^{-1}) at 3.5 m on NEGOM hydrographic cruises. Shown are cruises (a) N1, 16-26 November 1997, and (b) N2, 5-16 May 1998.

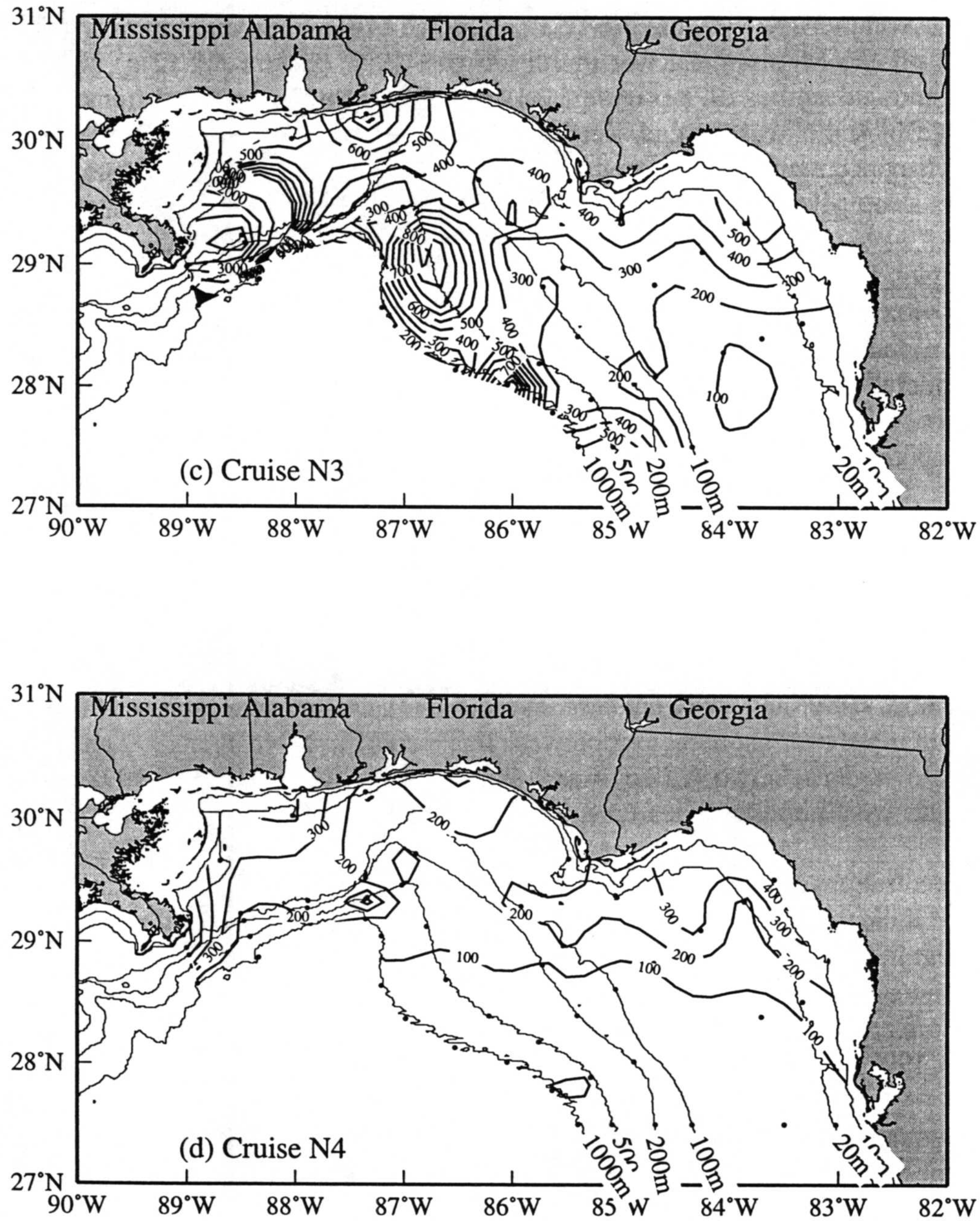


Figure 5.2.13. Chlorophyll *a* ($ng{\cdot}L^{-1}$) at 3.5 m on NEGOM hydrographic cruises. Shown are cruises (c) N3, 26 July-6 August 1998 and (d) N4, 13-24 November 1998. (continued)

rivers that carry moderate PM loads and nutrient-rich waters. Regionally, near-surface chlorophyll *a* concentrations differed during each sampling period with highs in the southeast region in November 1997 (Figure 5.2.12 a), along the Mississippi Bight in May 1998 (Figure 5.2.12 b), off the Mississippi River in July-August 1998 (Figure 5.2.12 c), and a uniform distribution in November 1998 (Figure 5.2.12 d). Chlorophyll *a* concentrations varied over a wide range in some seasons and were uniform in others. In general, near-surface water chlorophyll concentrations decreased with distance offshore. The subsurface fluorescence maxima chlorophyll *a* concentrations were similar to those in near-surface waters.

<u>Accessory Pigments</u>: Predominant accessory pigments detected were 19-butanoyloxyfucoxanthin, fucoxanthin, 19-hexanoyloxyfucoxanthin, chlorophyll *b*, c_2, c_3, zeaxanthin, and β-carotene (Table 5.2.4). Other accessory pigments that were present in trace amounts included violaxanthin, peridinin, prasinoxanthin, diadioxanthin, diatoxanthin and alloxanthin. It is informative in assessing the taxonomic make-up of phytoplankton communities from pigments to ratio the concentrations of each accessory pigment to chlorophyll *a*.

19-butanoyloxyfucoxanthin (19-but) is a pigment diagnostic of pelagophytes. The ratio of 19-but to chlorophyll *a* (19-but/chla) was similar during May and July-August 1998. High 19-but/chla ratios were observed along lines 9, 10, and 11 with ratios as high as 0.23. Offshore regions near lines 7 and 8 exhibited 19-but/chla ratios as high as 0.10 in May and July-August 1998. Throughout the rest of study area, 19-but/chla ratios were mostly below 0.05. During the two November samplings, 19-but/chla ratios were similar. Concentrations of 19-butanoyloxyfucoxanthin in the near-shore regions between line 3 and 7 in November 1997 and 1998 and in the offshore regions between line 9 and 11 in May and July-August 1998 suggest that pelagophytes were important members of the phytoplankton community.

High concentrations of fucoxanthin in combination with diadinoxanthin, diatoxanthin, and β-carotene indicate the presence of diatoms. Fucoxanthin to chlorophyll *a* ratios (fuco/chla) were similar in May and July-August 1998 ranging from 0.15 to 0.6. Fuco/chla ratios were low in the offshore region (below 0.2). Fuco/chla ratios were similar for both November samplings in near-shore coastal regions throughout the entire study region with ratios as high as 0.4. In November 1997 and 1998, fuco/chla ratios were below 0.05 in most offshore areas.

High concentrations of chlorophyll c_2 and c_3, fucoxanthin, diadioxanthin, and β-carotene indicate that prymnesiophytes are an important phytoplankton group. 19-hexanoyloxyfucoxanthin to chlorophyll *a* (19-hex/chla) ratios throughout the study area were as high as 0.9. For the November samplings, 19-hex/chla ratios in near-shore regions between lines 3 and 5 and lines 11 and 10 were as high as 0.5. The ratios were lower throughout the rest of the study area. The ratio of 19-hex/chla in May and July-August 1998 was as high as 0.9. Diadinoxanthin to chlorophyll *a* ratios (diad/chla) were high in the near-shore regions of lines 8 through 11 and 1 and 2 in November 1997, May 1998, and November 1998. Diad/chla ratios were as high as 0.7. The high concentrations of 19-hex/chla ratios and diad/chla observed during all four cruises, particularly along lines 3, 5, 10, and 11, indicates abundant prymnesiophytes.

High zeaxanthin to chlorophyll *a* ratios (zea/chla) are indicative of the presence of cynobacteria. Zea/chla ratios in November 1997, May 1998, and July-August 1998 were as high as 0.9. Zea/chla ratios were low in November 1998 ranging from 0.0 to 0.1. Chlorophyll *b/a* ratios were highest in November 1997, and in July-August 1998 were as high as 0.50. There were high chlorophyll *b* concentrations located in the central part of the study area between lines 8 and 10 during all sampling periods.

The major plankton groups in the study area are prymnesiophytes, pelagophytes, diatoms, cynobacteria, and prochlorophytes. The presence of only trace amounts of alloxanthin, peridinin, violaxanthin, prasinoxanthin and lutein in near-surface samples indicates that chrysophytes, cryptophytes, dinoflagellates, prasinophytes, and chlorophytes were not significant components of the phytoplankton community. There was little vertical variation in pigment compositions suggesting that phytoplankton composition was relatively uniform throughout the photic zone.

5.2.7 Integration of Water Column Properties

Integration of all the data collected aids in elucidating the importance of biogeochemical and physical processes in producing the observed spatial and temporal variations in the dissolved and particulate constituents of the water column in the study area. The water column study was designed to: (1) examine the relationship between dissolved oxygen, PM, POC, nepheloid layers, nutrients, phytoplankton pigments, and plankton community structure; (2) determine the origins of PM, POC, and nepheloid layers; and (3) estimate the importance of physical and biogeochemical maintaining or changing the observed patterns. As an initial approach, all water column properties were cross-correlated. Correlation coefficients were calculated for every combination of the variables measured. Several expected trends are apparent from the correlation matrix.

Potential temperature is positively correlated with time and location variables as expected. Temperature varies as a function of time year (cruise), distance from shore (station number), depth in the water column, and total depth of the water column. In contrast, salinity negatively correlates with nutrient and particulate matter concentrations. Salinity positively correlates with transmission in that transmission is inversely related to the concentration of particulates in the water column. These correlations are in response to the input of nutrient-rich, particulate-laden fresh water from rivers in the study area. Particulate and dissolved silicate concentrations are positively correlated (>0.8) with salinity. Phytoplankton pigment concentrations are negatively correlated with salinity with some being more highly correlated than others (β-carotene, diadioxanthin, and alloxanthin).

Dissolved nutrients are positively correlated with each other and negatively correlated with salinity. As expected nitrate, nitrite, urea and ammonia concentrations are intercorrelated. Nutrients are also positively correlated with particulate properties (PM, POC). However, nutrient concentrations are only moderately correlated with phytoplankton pigment concentrations suggesting that a significant non-living particulate matter source effects particulate distributions in the study area (i.e., the overriding influence of river discharges). Phosphate is highly correlated with the nitrogen containing nutrients reflecting a link both in uptake and remineralization. Phosphate positively correlates with silicate but to a lesser degree than for nitrate suggesting some independence in the origins of these nutrients. Silicate is negatively correlated with salinity and positively correlated with the nitrogen containing nutrients. Due to the co-occurrence of PM in river discharges, silicate is highly correlated with particulate properties, especially PM.

Particulate properties (PM, POC, chlorophyll *a*) were also closely correlated. As above, particulate properties were positively correlated with nutrients and negatively correlated with salinity and transmission reflecting riverine inputs. In general, PM was more highly correlated with these variables than POC reflecting the dual origin of POC and the predominately inorganic composition of PM in riverine discharges. PM and POC positively correlated with chlorophyll *a* concentrations with POC being more positively correlated than PM. Chlorophyll *a* was positively correlated with other phytoplankton pigments as expected. In most instances, phytoplankton pigments were intercorrelated with each other with a few exceptions.

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.